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A Site Inventory of Nature Preserves and State Forest in the Illinois River Section of the Illinois River and Mississippi River Sand Areas Natural Division

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Floristic assessment of the Henry Allan Gleason Nature Preserve, Mason County, Illinois

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ABSTRACT--The Henry Allan Gleason Nature Preserve is located in the extensive glacial sand deposits associated with the Illinois River in central Illinois. An extensive sand dune is present within the preserve on which undisturbed dry sand prairie, disturbed dry sand prairie, and blow-out communities are present. The undisturbed sand prairie is dominated by *Schizachyrium scoparium* (42% of the importance value [IV]), along with *Tephrosia virginiana*, *Opuntia humifusa*, and *Ambrosia psilostachya*. The disturbed sand prairie is dominated by *Eragrostis trichodes* (24% of the IV), followed by *Heterotheca camporum*, *Ambrosia psilostachya*, and *Rhus aromatica*. Common species in an active blow-out includes *Aristida tuberculosa* and *Cyperus grayioides*, while nearly stabilized blow-outs have a high diversity characterized by *Bouteloua hirsuta*, *Ambrosia psilostachya*, and *Eragrostis trichodes*. A total of 172 plant species were found: 4 fern and fern-allies, 3 gymnosperms, 39 monocots, 126 dicots. Thirty-one non-native species were found, comprising about 18% of the flora. The Floristic Quality Index for the nature preserve is 41.33 when the non-native species are included in the calculations.

INTRODUCTION

At the time of European settlement prairie vegetation covered about 60% of Illinois (Iverson et al. 1991). Though mostly tall-grass prairie, other types of prairie were also common, particularly sand prairies (Schwegman 1973). Sand deposits are common in the northern half of Illinois, accounting for about 5% of the state's land area. Most occur on glacial outwash plains resulting from erosional events associated with Wisconsin glaciation (Willman and Frye 1970, King 1981). One of the most extensive sand deposits is along the Illinois River in the central part of the state (Schwegman 1973). This sand deposit was formed as glacial lakes were drained about 14,500 years ago when glacial moraines were breached, resulting in the Kankakee Torrent. These waters carried huge amounts of sand and gravel that were deposited when the Kankakee Torrent entered the broad lowlands of the Illinois River below present day Hennepin. These sands were subsequently shaped by winds, creating the dune and swale topography known as the Parkland Formation (Willman and Frye 1970, Willman 1973).

The flora of the Illinois River sand deposits was studied by Gleason (1910) in his extensive review of the inland sand deposits of Illinois. Rodgers and Anderson (1979), using General Land Office survey records, examined presettlement vegetation of the area, while Anderson and Brown (1983, 1986) determined effects of fire on sand savannas and adjacent forest. More recently Jenkins et al. (1991) and Coates et al. (1992) studied the composition and structure of two sand forest communities in Mason County. Except for Gleason (1910) little information has been published on the composition of the sand prairie communities of these sand deposits. The present study was undertaken to determine vascular plant species composition, vegetation structure, and floristic quality of the major plant communities of the Henry Allen Gleason Nature Preserve (HAGNP).

STUDY SITE

HAGNP is located in extreme northwestern Mason County, just southeast of the town of Goofy Ridge, and about 15km northeast of Havanna, Illinois (SE1/4 S6, NE1/4 S7 T22N R7W). Officially dedicated in 1970, this site lies within the

Illinois River Section of the Mississippi River and Illinois River Sand Area Natural Division, and is within Sand Ridge State Forest (Schwegman 1973). The most significant physiographic feature at HAGNP is a large sand dune known as "Devil's Tower", which comprises about half of the preserve. This dune is more than 25 m tall, and has a large blow-out located near the summit.

When dedicated, much of the 44.5 ha prairie had been heavily disturbed. The entire site was designated "grade C" dry sand prairie by the Illinois Natural Areas Inventory, which indicates that the site has been disturbed, though some small remnants of original sand prairie still existed (White 1978). Most of the large dune had been planted in pine trees. When these were removed in 1978 many were 7 m tall with the diameter at breast height ranging from 20-25 cm. The first prescribed burn on the preserve was in the spring of 1980 with successive burns in 1982, 1993, 1997, and 1999. The soils of the preserve are excessively drained Plainfield sands (Calsyn 1995).

Climate at the HAGNP is continental with warm summers and cold winters. Based on weather data from Havanna, 15km to the southwest, mean annual precipitation is 96.0cm, with May having the highest rainfall (11.3cm). Mean annual temperature is 10.8°C with the hottest month being July (average of 24.6°C), and the coldest January (average of -5.0°C). Frost-free days range from 140 to 206, with the average being 173 day per year (Midwestern Regional Climate Center 2002).

METHODS

The HAGNP was visited throughout the growing seasons of 1998 to 2002 and voucher specimens of each plant species were collected, identified, and deposited in the Stover-Ebinger Herbarium of Eastern Illinois University, Charleston, Illinois (EIU). Criteria for designating non-native species follows Mohlenbrock (1986) and Gleason and Cronquist (1991), while nomenclature follows Mohlenbrock (1986).

Within the undisturbed dry sand prairie, the disturbed dry sand prairie, and an active blow-out, line transects 25m long were placed, four in each of the three community types. The transects, surveyed in September of 2000, were stratified across each community, and oriented so that it occurred entirely within a single community type. In addition, three partially stabilized blow-outs having some areas of shifting sand were studied. Due to their small size, two 15 m transects were randomly placed in each. Along each transect, m^2 (1m x 1m) quadrats were located at 1m intervals (n=25/transect), except in the partially stabilized blowout communities where $1/4m^2$ (50cm x 50cm) quadrats were used (n=15/transect). Odd-numbered quadrats were located on the right side of the transect line, even-numbered quadrats on the left. Cover for each species was determined by using the Daubenmire canopy cover class system (Daubenmire 1959) as modified by Bailey and Poulton (1968)(class 1 = 0 to 1%; class 2 = 2 to 5%; class 3 = 6 to 25%; class 4 = 26 to 50%; class 5 = 51 to 75%; class 6 = 76 to 95%; class 7 = 96 to 100%). Importance value (IV) was determined by summing relative cover and relative frequency (total IV = 200), while average cover was determined by dividing the total cover of each species by the number of plots surveyed in each community type.

The Floristic Quality Index (FQI) was determined using the coefficient of conservatism (CC) assigned to each species (Taft et al. 1997). The CC for each taxon was determined by assigning each an integer from 0 to 10 based on the species tolerance to disturbance and its fidelity to habitat integrity. This index provides a measure of the floristic integrity or degree of disturbance to a site. The FQI is a weighted index of species richness (N), and is the arithmetic product of the mean CC, multiplied by the square-root of the species richness ($\sqrt{N}$) of an inventory site: FQI = mean CC($\sqrt{N}$). For relatively small areas, FQI gives a rapid means of comparison and an indication of the floristic integrity of the site. When used along with other floristic measures, such as

quadrat-based sampling methods, it provides a method of making quantitative comparisons between sites. Prairies with an FQI of 35 or higher are considered good quality natural areas (Taft et al. 1997).

RESULTS AND DISCUSSION

A total of 172 vascular plant species representing 137 genera and 56 families were documented from the 44.5 ha preserve (Appendix I). Fern, fern-allies and gymnosperms were represented by only seven species. Of the remainder, 39 were monocots in 5 families and 28 genera, and 126 were dicots in 46 families and 103 genera. Thirty-one non-native species were found, and 31 species of trees and shrubs were collected. The predominant plant families were the Asteraceae and Poaceae, each with 28 species. The Illinois endangered *Lesquerella ludoviciana* and the Illinois threatened *Cyperus grayioides* were found on the preserve (Herkert and Ebinger (2002).

Active blow-out community: Only 12 plant species were encountered in the active blow-out. Average bare ground and litter accounted for 83% of the cover. *Aristida tuberculosa* was the dominant species, followed by *Cyperus grayioides,* and *Diodia teres* (Table 1). Only eight species were encountered in the plots and all but three had IV's lower than 10.

Partially stabilized blow-out communities: Three small, nearly stabilized blow-outs were examined, two located near the top of Devil's Tower, the third near the top of a low ridge in the southwestern part of the preserve. On these partially stabalized blow-outs bare ground and litter cover averaged 52% (Table 2). All had a similar flora and shared dominant species with at least three species with highest IVs in each blow-out occurring among the top five species when the data were combined (Table 2). *Bouteloua hirsuta* was usually the dominant species, followed by *Ambrosia psilostachya*, and commonly *Eragrostis trichodes, while Lesquerella ludoviciana* was an important component. In Illinois this endangered species is known only from the HAGNP where it occurs only in these three partially stabilized blow-out communities.

Disturbed dry sand prairie: Gleason (1910) indicated that Devil's Tower was originally covered with prairie but most had been destroyed by cultivation and pasturing, only a few small areas remained in their natural condition. Later the slopes of this dune were planted in pines that were removed in 1978. Presently these slopes contain a disturbed dry sand prairie having a high species diversity including some taxa commonly associated with mature sand prairies: *Schizachyrium scoparium, Opuntia humifusa*, and *Dichanthelium villosissimum*. In this disturbed sand prairie *Eragrostis trichodes* dominated followed by *Heterotheca camporum, Ambrosia psilostachya*, and *Rhus aromatica* (Table 3).

Mature dry sand prairie: Mature dry sand prairies are located on the east and northwest sides of the preserve on the lower flanks of Devil's Tower. Rarely exceeding 100 m by 75 m in size, these areas contain many species common to dry sand prairies (Gleason 1910, White and Madany 1978). *Schizachyrium scoparium* was the leading dominant. *Tephrosia virginiana* and *Opuntia humifusa were* second and third in IV respectively, while *Ambrosia psilostachya* and *Dichanthelium villosissimum* also had IVs that exceeded 15 (Table 4).

This dry sand prairie, referred to as the bunch-grass association by Gleason (1910), was dominated by many clumps of *Schizachyrium scoparium* that were 20-60 cm across, nearly circular in outline, and formed a dense mass through which few other plant species could grow. Some larger clumps had centers that had died, forming rings in which no other species were found. *Dichanthelium villosissimum* has a similar growth pattern but formed smaller clumps. Many of

the forbs, particularly *Ambrosia psilostachya, Commelina erecta*, and *Conyza canadensis* grew in the spaces between the clumps. The bunch-grass community described by Gleason (1910) is very similar to the undisturbed dry sand prairie community found during the present study.

Blowing sand was a common characteristic of the sand communities. Even on relatively calm days there was moving sand in the blow-outs. Here vegetation was sparse, and most of the area was exposed sand (bare ground cover of 83%). In the nearly stabilized blow-outs, ground cover was about 50%. Where bunch grasses were common, however, the amount of open sand decreased significantly (bare ground cover of 35%).

The Floristic Quality Index for the HAGNP was 41.33 with 31 non-native species included in the calculations. Removing these exotic species from the calculations increased the FQI to 45.64 with a mean coefficient of conservation of 3.84. Of the native species encountered, 13 had a coefficient of conservatism of 8 or higher and were relatively common components of the flora. In contrast, non-native taxa were restricted to the margins of the preserve, in areas of human disturbance, and were not common components of study sites. None were encountered in the blow-out community (Table 1), or in the mature dry sand prairie (Table 4). In the stabilized blow-out community the only non-native was *Salsola iberica* (Table 2), while the only exotics in the disturbed dry sand prairie were *Poa pratensis* and *Helianthus petiolaris*, both being uncommon (Table 3).

Present management practices on the HAGNP consists of occasional fires to control wood encroachment. These burns have decreased litter accumulation and appear to have been helpful in increasing prairie quality and decreasing the number of exotic species on the prairie. Presently both the undisturbed and disturbed sand prairie communities contain many native sand prairie taxa and very few exotics. Though not apparent from this study, woody species are becoming common in parts of the preserve and more frequent fires will be needed to stop woody encroachment.

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Table 1. Frequency (%), average cover (% of total area), relative frequency, relative cover, and importance value of ground layer species in an active blow-out at Henry Allan Gleason Nature Preserve, Mason County, Illinois.

Species	Freq.	Average Cover	Rel. Freq.	Rel. Cover	I. V.
Aristida tuberculosa	86	5.88	49.6	45.9	95.5
Cyperus grayioides	56	4.55	32.4	35.6	68.0
Diodia teres	14	0.85	8.1	6.7	14.8
Panicum virgatum	4	0.60	2.3	4.7	7.0
Rhus aromatica	2	0.53	1.2	4.1	5.3
Dichanthelium villosissimum	4	0.34	2.3	2.6	4.9
Crotonopsis linearis	6	0.03	3.5	0.2	3.7
Ambrosia psilostachya	1	0.03	0.6	0.2	0.8
Totals		12.81	100.0	100.0	200.0
Average bare ground and litter		83.75			

Table 2. Frequency (%), average cover (% of total area), relative frequency, relative cover, and importance value of ground layer species in stabilized blow-outs at Henry Allan Gleason Nature Preserve, Mason County, Illinois.

Species	Freq.	Average Cover	Rel. Freq.	Rel. Cover	I. V.
Bouteloua hirsuta	72	8.92	11.9	22.6	34.5
Ambrosia psilostachya	80	6.33	13.2	16.0	29.2
Eragrostis trichodes	67	5.69	11.0	14.4	25.4
Aster oblongifolius	31	3.57	5.2	9.1	14.3
Rhus aromatica	19	3.55	3.1	9.0	12.1
Lesquerella ludoviciana	43	1.04	7.2	2.6	9.8
Koeleria macrantha	21	2.23	3.5	5.6	9.1
Oenothera rhombipetala	40	0.37	6.6	0.9	7.5
Opuntia humifusa	22	1.49	3.7	3.8	7.5
Heterotheca camporum	17	1.03	2.8	2.6	5.4
Paspalum bushii	20	0.76	3.3	1.9	5.2
Chamaesyce geyeri	26	0.21	4.2	0.5	4.7
Conyza canadensis	22	0.38	3.7	1.0	4.7
Commelina erecta	20	0.35	3.3	0.9	4.2
Calamovilfa longifolia	20	0.24	3.3	0.6	3.9
Schizachyrium scoparium	8	1.03	1.3	2.6	3.9
Brickellia eupatorioides	7	0.73	1.1	1.9	3.0
Cassia fasciculata	14	0.13	2.4	0.3	2.7
Phlox bifida	10	0.24	1.7	0.6	2.3
Liatris aspera	8	0.28	1.3	0.7	2.0
Leptoloma cognatum	6	0.41	0.9	1.0	1.9
Croton glandulosa	9	0.04	1.5	0.1	1.6
Aster ericoides	4	0.21	0.7	0.5	1.2
Asclepias viridiflora	4	0.05	0.7	0.1	0.8
Lespedeza capitata	1	0.17	0.2	0.4	0.6
Dichanthelium villosissimum	2	0.07	0.4	0.2	0.6
Poinsettia dentata	3	0.02	0.6	--	0.6
Salsola iberica	2	0.01	0.4	--	0.4
Teucrium canadense	2	0.01	0.4	--	0.4
Strophostyles helvola	1	0.03	0.2	0.1	0.3
Euphorbia corollata	1	0.01	0.2	--	0.2
Totals		39.60	100.0	100.0	200.0
Average bare ground and litter		52.40			

Table 3. Frequency (%), average cover (% of total area), relative frequency, relative cover, and importance value of ground layer species in a disturbed sand prairie at Henry Allan Gleason Nature Preserve, Mason County, Illinois.

Species	Freq.	Average Cover	Rel. Freq.	Rel. Cover	I. V.
Eragrostis trichodes	98	16.15	21.0	26.8	47.8
Heterotheca camporum	67	17.64	14.3	29.2	43.5
Ambrosia psilostachya	82	9.51	17.6	15.7	33.3
Rhus aromatica	36	9.20	7.7	15.2	22.9
Opuntia humifusa	64	3.28	13.7	5.4	19.1
Commelina erecta	28	0.83	6.0	1.4	7.4
Conyza canadensis	12	0.53	2.8	0.9	3.7
Calamovilfa longifolia	10	0.56	2.1	0.9	3.0
Sporobolus clandestinus	7	0.69	1.5	1.1	2.6
Dichanthelium oligosanthes	8	0.34	1.7	0.6	2.3
Aster oblongifolius	4	0.60	0.9	1.0	1.9
Dichanthelium villosissimum	5	0.13	1.1	0.2	1.3
Oenothera rhombipetala	4	0.19	0.9	0.3	1.2
Physalis heterophylla	4	0.12	0.9	0.2	1.1
Schizachyrium scoparium	4	0.10	0.9	0.2	1.1
Croton glandulosus	4	0.05	0.9	0.1	1.0
Poa pratensis	4	0.05	0.9	0.1	1.0
Aristida tuberculosa	4	0.02	0.9	--	0.9
Euphorbia corollata	3	0.07	0.6	0.1	0.7
Helianthus petiolaris	3	0.18	0.4	0.3	0.7
Sporobolus cryptandrus	3	0.04	0.6	0.1	0.7
Liatris aspera	2	0.04	0.4	0.1	0.5
Paspalum bushii	2	0.06	0.4	0.1	0.5
Cassia fasciculata	2	0.01	0.4	--	0.4
Chamaesyce geyeri	2	0.01	0.4	--	0.4
Asclepias verticillata	1	0.01	0.2	--	0.2
Chenopodium desiccatum	1	0.01	0.2	--	0.2
Cyperus schweinitzii	1	0.01	0.2	--	0.2
Lactuca candensis	1	0.01	0.2	--	0.2
Triplasis purpurea	1	0.01	0.2	--	0.2
Totals		60.45	100.0	100.0	200.0
Average bare ground and litter		47.98			

Table 4. Frequency (%), average cover (% of total area), relative frequency, relative cover, and importance value of ground layer species in a mature sand prairie at Henry Allan Gleason Nature Preserve, Mason County, Illinois.

Species	Freq.	Average Cover	Rel. Freq.	Rel. Cover	I. V.
Schizachyrium scoparium	97	37.06	25.5	59.1	84.6
Tephrosia virginiana	43	10.03	11.3	16.0	27.3
Opuntia humifusa	66	4.88	17.3	7.8	25.1
Ambrosia psilostachya	58	2.27	15.2	3.6	18.8
Dichanthelium villosissimum	50	3.37	13.1	5.4	18.5
Rhus aromatica	7	2.88	1.8	4.6	6.4
Eragrostis trichodes	11	1.40	2.9	2.2	5.1
Commelina erecta	13	0.14	3.4	0.2	3.6
Panicum virgatum	10	0.27	2.6	0.4	3.0
Crotonopsis linearis	10	0.05	2.6	0.1	2.7
Conyza canadensis	5	0.08	1.3	0.1	1.4
Leptoloma cognatum	3	0.07	0.8	0.1	0.9
Stipa spartea	2	0.18	0.5	0.3	0.8
Aristida tuberculosa	3	0.02	0.8	--	0.8
Eragrostis spectabilis	1	0.03	0.3	0.1	0.4
Koeleria macrantha	1	0.01	0.3	--	0.3
Cyperus schweinitzii	1	0.01	0.3	--	0.3
Totals		62.75	100.0	100.0	200.0
Average bare ground and litter		35.44			

APPENDIX I. Vascular species encountered at Henry Allen Gleason Nature Preserve, Mason County, Illinois, listed alphabetically by family under the major plant groups. An asterisk indicates non-native (exotic) species (*). For each species the author's collecting number (JEE) is given.

FERN AND FERN-ALLIES
Aspleniaceae
Asplenium platyneuron (L.) Oakes 28399
Woodsia obtusa (Spreng.) Torr. 29639

Equisetaceae
Equisetum hyemale L. 28243

Ophioglossaceae
Botrychium virginianum (L.) Sw. 29640

GYMNOSPERMES
Cupressaceae
Juniperus virginiana L. 28146

Pinaceae
**Pinus banksiana* Lamb. 28646
**Pinus strobus* L. 30366

MONOCOTS
Commelinaceae
Commelina erecta L. 28131
Tradescantia ohiensis Raf. 28145

Cyperaceae
Carex meadii Dewey 25791
Carex muhlenbergii Willd. 28110
Carex tonsa (Fern.) Bickn. 29223
Cyperus filiculmis Vahl. 25290
Cyperus grayioides Mohlenbr. 25291
Cyperus schweinitzii Torr. 25793

Liliaceae
**Allium vineale* L. 28650
Smilacina stellata (L.) Desf. 28323

Poaceae
Agrostis hyemalis (Walt.) BSP. 25790
Aristida desmantha Trin. & Rupr. 28237
Aristida purpurascens Poir. 28239
Aristida tuberculosa Nutt. 28238
Bouteloua hirsuta Lag. 25293
**Bromus commutatus* Schrad. 28655
**Bromus inermis* Leyss. 30186
**Bromus tectorum* L. 28400
Calamovilfa longifolia (Hook.) Scribn. 28124
Dichantheliumm oligosanthes Schult. 25794
Dichanthelium villosissimum Nash 28128
**Digitaria sanguinalis* (L.) Scop. 30902
Elymus canadensis L. 28121
Eragrostis spectabilis (Pursh) Steud. 28140
Eragrostis trichodes (Nutt.) Wood 28136

Koeleria macrantha (Ledeb.) Spreng. 25792
Leptoloma cognatum (Schult.) Chase 28154
Panicum virgatum L. 28114
Paspalum bushii Nash 25292
**Poa pratensis* L. 25800
Schizachyrium scoparium (Michx.) Nash 28241
Sorghastrum nutans (L.) Nash 28240
Sporobolus clandestinus (Biehler) Hitchcock 28236
Sporobolus cryptandrus (Torr.) Gray 29417
Stipa spartea Trin. 25796
Tridens flavus (L.) Hitchcock 28143
Triplasis purpurea (Walt.) Chapm. 28235
Vulpia octoflora (Walt.) Rydb. 28401

Smilacaceae
Smilax hispida Muhl. 29416

DICOTS
Amaranthaceae
Froelichia floridana (Nutt.) Moq. 25289

Anacardiaceae
Rhus aromatica Ait. 28117
Rhus glabra L. 29414
Toxicodendron radicans (L.) Kuntze 28397

Apiaceae
Osmorhiza longistylis (Torr.) DC. 29642
Sanicula canadensis L. 28652

Apocynaceae
Apocynum sibiricum Jacq. 28649

Asclepiadaceae
Asclepias syriaca L. 28644
Asclepias verticillata L. 28123
Asclepias viridiflora Raf. 25799

Asteraceae
**Achillea millefolium* L. 28657
Ambrosia artemisiifolia L. 28148
Ambrosia psilostachya DC. 28147
Aster ericoides L. 28136
Aster oblongifolius Nutt. 28250
Aster pilosus Willd. 28251
Bidens bipinnata L. 28141
Brickellia eupatorioides (L.) Shinners 28139
Cirsium discolor (Muhl.) Spreng. 29228
Conyza canadensis (L.) Cronq. 28246
Coreopsis lanceolata L. 25795
Coreopsis palmata Nutt. 28144
Erigeron annuus (L.) Pers. 28647
Erigeron stigosus Muhl. 25803
Eupatorium rugosum Houtt. 28149
Eupatorium serotinum Michx. 28247
Gnaphalium obtusifolium L. 28248
**Helianthus petiolaris* Nutt. 25287

Heterotheca camporum (Greene) Shinners 28127
Krigia virginica (L.) Willd. 25788
Lactuca canadensis L. 28158
**Lactuca serriola* L. 29227
Liatris aspera Michx. 28249
Rudbeckia hirta L. 28645
Senecio plattensis Nutt. 28326
Solidago canadensis L. 29415
Solidago nemoralis Ait. 28142
**Tragopogon dubius* Scop. 25784

Boraginaceae
Hackelia virginiana (L.) I. M. Johnston 30903
Lithospermum caroliniense (J. F. Gmel.) MacM. 25789

Brassicaceae
**Alliaria petiolata* (Bieb.) Cavara & Grande 28407
Arabis canadensis L. 28402
**Lepidium densiflorum* Schrad. 30854
Lepidium virginicum L. 28126
Lesquerella ludoviciana (Nutt.) S. Wats. 27791

Cactaceae
Opuntia humifusa (Raf.) Raf. 28129

Caesalpiniaceae
Cassia fasciculata Michx. 18132
Gymnocladus dioicus (L.) K. Koch 28818

Campanulaceae
Campanula americana L. 28159
Triodanis perfoliata (L.) Nieuwl. 25787

Caryophyllaceae
**Holosteum umbellatum* L. 28321
**Saponaria officinalis* L. 25803
Silene antirrhina L. 25801

Celastraceae
Celastrus scandens L. 28157
Euonymus atropurpurea Jacq. 28327

Chenopodiaceae
Chenopodium desiccatum A. Nels. 28118
Cycloloma atriplicifolium (Spreng.) Coult. 25288
**Salsola iberica* Sennen & Pav. 28134

Cistaceae
Helianthemum canadense (L.) Michx. 28244

Convolvulaceae
**Ipomoea hederacea* (L.) Jacq. 29226
Ipomoea lacunosa L. 29225

Cornaceae
Cornus drummondii C.A. Mey. 30188

Euphorbiaceae
Chamaesyce geyeri (Engelm. & Gray) Small 28160
Croton glandulosus L. 25286a
Crotonopsis linearis Michx. 28116
Euphorbia corollata L. 28122
Poinsettia dentata (Michx.) Kl. & Garcke 25286b

Fabaceae
Desmodium sessilifolium (Torr.) Torr. & Gray 30367
Lespedeza capitata Michx. 28242
**Melilotus alba* Medic. 30189
**Melilotus officinalis* (L.) Pallas 28398
**Robinia pseudoacacia* L. 28651
Strophostyles helvola (L.) Ell. 30368
Tephrosia virginiana (L.) Pers. 28115

Fagaceae
Quercus x bushii Sarg. 28112
Quercus marilandica Muenchh. 28156
Quercus velutina Lam. 28643

Geraniaceae
Geranium carolinianum L. 28403

Grossulariaceae
Ribes missouriense Nutt. 30190

Juglandaceae
Juglans nigra L. 28648

Lamiaceae
Monarda puntata L. 28819
Physostegia virginiana (L.) Benth. 30369
Teucrium canadense L. 28119

Malvaceae
Callirhoe triangulata (Leavenw.) Gray 28155

Menispermaceae
Menispermum canadense L. 28816

Molluginaceae
**Mollugo verticillatus* L. 28658

Moraceae
**Cannabis sativa* L. 30192
**Maclura pomifera* (Raf.) Schneider 30193
**Morus alba* L. 28408

Nyctaginaceae
**Mirabilis nyctaginea* (Michx.) MacM. 25797

Onagraceae
Oenothera biennis L. 30904
Oenothera rhombipetala Nutt. 28133

Oxalidaceae

Oxalis stricta L. 28659

Papaveraceae
Corydalis micrantha (Engelm.) Gray 28410

Phytolaccaceae
Phytolacca americana L. 28150

Plantaginaceae
**Plantago patagonica* Jacq. 25785

Polemoniaceae
Phlox bifida Beck 28135

Polygonaceae
Polygonum cristatum Engelm. & Gray 28120
Polygonum tenue Michx. 29229
**Rumex acetosella* L. 28153

Portulacaceae
Talinum rugospermum Holz. 29992

Ranunculaceae
Anemone caroliniana Walt. 25208

Rosaceae
Fragaria virginiana Duchesne 28245
Geum canadense Jacq. 28653
Malus ioensis (Wood) Britt. 30187
Prunus angustifolia Marsh. 28151
Prunus serotina Ehrh. 28656
Rosa carolina L. 28654
**Rosa multiflora* Thunb. 28404
Rubus allegheniensis Porter 28406
Rubus occidentalis L. 28405

Rubiaceae
Diodia teres Walt. 28130
Galium aparine L. 28660

Rutaceae
Ptelea trifoliata L. 28152
Zanthoxylum americanum Mill. 28125

Scrophulariaceae
Linaria canadensis (L.) Dum.-Cours. 25786
Penstemon pallidus Small 28114
**Veronica arvensis* L. 29641

Solanaceae
Physalis heterophylla Nees. 25798
Solanum carolinense L. 29224

Verbenaceae
Verbena stricta Vent. 28111
Verbena urticifolia L. 30905

Violaceae
Viola pedata L. 28324
**Viola rafinesquii* Greene 28322

Vitaceae
Parthenocissus quinquefolia (L.) Planch. 28817
Vitis vulpina L. 28410

Sand prairie communities of Matanzas Nature Preserve, Mason County, Illinois

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ABSTRACT--The Matanzas Prairie Nature Preserve is located in the extensive glacial sand deposits associated with the Illinois River near Bath, Mason County, Illinois. This preserve contains the only remaining high quality wet-mesic sand prairie and sedge meadow associated with the Illinois River sand deposits. The sedge meadow, about 5 ha in size, was dominated by *Carex stricta* (IV of 66.6 out of 200), *Calamagrostis canadensis*, and *Rosa palustris* (both with IV's of 28.3). The wet-mesic sand prairie, occurs on slightly higher ground, and was dominated by *Solidago canadensis*, *Andropogon gerardii*, *Carex* spp., *Poa pratensis*, and *Euthamia graminifolia*. In some parts of the preserve it gradually changes to shrub prairie with a similar ground layer. A total of 342 species of vascular plants species were encountered on the preserve; 5 fern and fern-allies, 100 monocots, and 237 dicots. Except for *Poa pratensis*, which was among the dominant species in the wet-mesic sand prairie and shrub prairie, the 38 exotic species were rarely encountered (11% of the flora). The Floristic Quality Index for the sedge meadow was _____, the wet-mesic sand prairie _____, and the shrub prairie _____.

INTRODUCTION

At the time of European settlement prairie vegetation covered about 60% of Illinois (Iverson et al. 1991). Most was black soil, tall-grass prairie in the prairie peninsula, though sand prairie was also relatively common (Transeau 1935, Schwegman 1973). In the northern half of Illinois extensive sand areas exist on glacial outwash plains associated with erosional events of the Wisconsin glaciation (Willman and Frye 1970, King 1981). The two most extensive are the Kankakee sand deposits in northeastern Illinois, and the Illinois River sand deposits in the central part of the state (Schwegman 1973). Both were formed about 14,500 years ago as a result of depositional events associated with the Kankakee Torrent (Willman and Frye 1970, Willman 1973).

The flora of the Illinois River sand deposits were first studied by Gleason (1910) in his extensive review of the inland sand deposits of Illinois. Rodgers and Anderson (1979) examined presettlement vegetation of the area, while Anderson and Brown (1983, 1986) determined effects of fire on sand savannas and adjacent forest. Later Jenkins et al. (1991) and Coates et al. (1992) studied the composition and structure of sand forest communities. Recently a study of the flora of a dry sand prairie was completed (McClain et al. 2004). As the Matanzas Prairie Nature Preserve contains the only preserved remnant of sedge meadow and wet-mesic sand prairie in the Illinois River sand deposits, it was decided to examine the vascular plant species composition, vegetation structure, and floristic quality of the native plant communities in this preserve.

DESCRIPTION OF THE STUDY SITE

The Matanzas Prairie Nature Preserve is located in southwestern Mason County, 2 km northeast of Bath, and 10 km south of Havana, Illinois (NE1/4 S4 T20N R9W). Officially dedicated in 1985, this site lies within the Illinois

River Section of the Mississippi River and Illinois River Sand Area Natural Division (Schwegman 1973). The preserve contains high quality wet-mesic sand prairie, shrub prairie, and sedge meadow communities that occur in only a few other places in Illinois. These communities have been assigned a rarity index of 5 (1 common, 5 very rare) by the Illinois Natural Areas Inventory (White 1978). The preserve is 23 ha in size, the northern part of about 11 ha contains high quality prairie and sedge meadow remnants, the southern part, 12 ha in size, is cultivated land that has been fallow since 1986.

In the Illinois River sand deposits, these wet area communities mostly occurred in the low-lying portions of out-wash and lake-plains. Most of these communities were drained and converted to agricultural lands. A few attempts were made to drain the preserve, and a few channels are still obvious. The large ditch that divides the preserve into two parts has been damned by Beavers, and is usually filled with water. The northern part of the preserve was designated "grade B" wet sand prairie and sedge meadow by the Illinois Natural Areas Inventory (White 1978).

The soils of the preserve are wet Plainfield sands high in organic matter (Calsyn 1995). Climate is continental with warm summers and cold winters. Based on weather data from Havana, 10 km to the north, mean annual precipitation is 96.0 cm, with May having the highest rainfall (11.3 cm). Mean annual temperature is 10.8°C with the hottest month being July (average of 24.6°C), and the coldest January (average of -5.0°C). Frost free days range from 140 to 206, with the average being 173 day per year (Midwestern Regional Climate Center 2002).

METHODS

The Matanzas Prairie Nature Preserve was visited throughout the growing season of 1991 and at various other times between 1998 and 2002. During these visits the extent of the plant communities was determined and habitat data for each taxon noted. Voucher specimens of each plant species were collected, identified, and deposited in the herbarium of the Illinois Natural History Survey, Champaign, Illinois (ILLS). Criteria for designating non-native species followed Fernald (1950), Mohlenbrock (1986), and Gleason and Cronquist (1991). Nomenclature follows Mohlenbrock (1986).

Transects 25 m long were located randomly in cardinal compass directions throughout each of three community types: sedge meadow, wet-mesic sand prairie, and shrub prairie. The sedge meadow was studied in July 1999 and again in September 2001 using two transects each time (50 plots each year), the wet-mesic sand prairie was examined in September 1999 using four transects (100 plots), while the shrub prairie was surveyed in September 2001 using two transects (50 plots). Along each transect, ¼ m^2 quadrates were located at 1 m intervals, odd numbered quadrates on the right, even numbered quadrates on the left. Cover for each species was determined by using the Daubenmire cover class system (Daubenmire 1959) as modified by Bailey and Poulton (1968). Importance value (IV) for ground layer species was determined by summing relative cover and relative frequency.

The Floristic Quality Index (FQI) for each of the three communities was determined by using the coefficient of conservatism (CC) assigned to each species based on the species tolerance to disturbance and its fidelity to habitat integrity (Taft et al. 1997). As used here, the FQI is a weighted index of species richness (N), and is the arithmetic product of the mean CC, multiplied by the square-root of the species richness ($\sqrt{N}$) of a sites: FQI = mean CC($\sqrt{N}$). For relatively small areas the FQI gives an indication of the

floristic integrity of the site. When used along with other floristic measures, such as quadrate-based sampling methods, it is useful in making site comparisons. Prairie sites with an FQI of 35 or higher are considered high quality natural areas (Taft et al. 1997).

RESULTS

A total of 342 species representing 194 genera and 71 families were documented for the site (Appendix I). Fern and fern-allies were represented by only five species. Of the remainder, 100 were monocots in 11 families and 47 genera, and 237 were dicots in 56 families and 143 genera. Of these taxa, 38 were not native to Illinois, and except for *Poa pratensis*, most were uncommon, only occasionally being encountered. One Illinois endangered species, *Platanthera flava* var. *herbiola*, and one Illinois threatened species, *Tomanthera auriculata* were found (Herkert and Ebinger 2002). The largest families were the Asteraceae (45 species), Poaceae (44), Cyperacea (36), Polygonaceae (15), and Rosaceae (14).

Plant community types were determined according to the Illinois Natural Areas Inventory (White and Madany 1978). In addition to extensive disturbed and cultural communities, three communities with high to relatively high natural quality were designated: sedge meadow, wet-mesic sand prairie, and shrub prairie. All were located in the northern half of the preserve and show a gradual transition from one to the other depending on elevation and water availability.

Sedge Meadow Community: This community occupied the eastern half of the northern part of the preserve. Surface water was present during the winter and spring and the soil was nearly always saturated. In the 1999 survey the sedge meadow was dominated by *Carex stricta* (IV of 66.6), *Calamagrostis canadensis* and *Rosa palustris* (both with IV's of 28.3)(Table 1). Only 18 other taxa were present, all native species, and all with relatively low importance values. Numerous colonies of *Rosa palustris* existed throughout the sedge meadow, accounting for nearly one quarter of the entire area. In these colonies few other species occurred. The sedge meadow was burned in the fall of 2001. In the 2001 survey major changes in the flora of the sedge meadow were observed (Table 1). There was a dramatic decrease in *Rosa palustris* and a switch in dominance to *Calamagrostis canadensis* (IV of 69.1). This species was especially robust, covering over other species in some areas. In contrast, the *Rosa palustris* had been top-killed, but was resprouting. More species were encountered in the quadrates of the 2001 survey, some species previously present were more common, others much less common or not observed (Table 1). The FQI of the sedge meadow was _____ in 2001.

Wet-mesic sand prairie: In the wet-mesic sand prairie, located in the northwestern part of the preserve, surface water was present for short periods even during the growing season and the soil had a dark A horizon. This community was dominated by *Solidago canadensis* (IV of 34.2) followed by *Andropogon gerardii* (25.9) and *Carex* spp. (21.9) most of which was *C. stricta (Table 2)*. Fourth in dominance, the exotic species *Poa pratensis*, was found throughout much of the wet-mesic prairie. Numerous species were encountered, 52 occurring in the quadrates with many other taxa being observed. Most were uncommon, however, 15 being encountered only once in the plots (Table 2). The FQI of the wet-mesic sand prairie was _____.

Shrub prairie: In some areas of the preserve the wet-mesic sand prairie gradually changes to shrub prairie. This shrub prairie exists since it rarely burns, mostly because of wet depressions that prevent the movement of fire.

Cornus drummondii, *Cornus obliqua*, *Rosa palustris*, *Rubus* spp., and *Salix discolor* were common woody species of the shrub prairie along with *Betula nigra*, which occasionally forms thickets. The ground layer species were similar to those associated with the wet-mesic sand prairie, although the rarer taxa were not encountered (Table 2). The FQI of the shrub prairie was _____.

DISCUSSION

The sedge meadow at the Matanzas Prairie Nature Preserve is similar to three sedge meadows studied in Lee County, Illinois (Handel et al. 2003). Species composition was similar with *Carex stricta* having very high importance values, and many of the subordinate species also being present. The Lee County sedge meadows, however, had higher species diversity, and *Onoclea sensibilis* ranked high in IV, while it was very uncommon at the Matanzas Prairie site. In contrast, *Calamagrostis canadensis* ranked high in IV on the Matanzas Prairie sedge meadow, being relative uncommon in the Lee County sedge meadows.

Similar results were obtained when comparing the prairie remnants studied in Lee County (Handel et al. 2003) with the wet-mesic sand prairie at Matanzas Prairie. Many of the species were common to both sites, as were some of the dominant species. Both sites had high species diversity and *Andropogon gerardii* and *Euthamia graminifolia* generally had high IV's. The Lee County prairie remnants, however, were drier and would be classified as mesic prairies.

The persistent presence of *Poa pratensis* in the ground layer of the wet-mesic sand prairie and the shrub prairie at the Matanzas Prairie Nature Preserve indicates that in the past this area was heavily grazed (Tables 3 and 4). More intensive management will be needed to reduce the importance of *Poa pratensis*. Management practices presently employed at the Matanzas Prairie Nature Preserve are only partially successful. A more aggressive fire regime is needed to decrease the extent of the exotic *Poa pratensis*, which would probably decrease in importance with the use of early spring burns.

In the past woody encroachment was extensive at the preserve and a 2-3 ha forest dominated by *Betula nigra* was present between the sedge meadow and the shrub prairie (Uhlarik et al. 1990). In this small forest, tree density averaged 579 stems/ha and basal area averaged 24.04 m^2/ha. *Betula nigra*, which accounted for 90% of the importance value, had an average diameter of 22.6 cm dbd. Prescribed burns within the past 13 years have decreased the size of this small forest, and many of the trees are dead or dying. These prescribed burns should be continued, and probably increased in frequency, to stop woody encroachment in the shrub prairie. Also, the population of the state threatened *Tomanthera auriculata* on the preserve has decreased in the past 12 years. This rare species is associated with disturbances, and its seeds require light for germination (Midewin National Tallgrass Prairie 1999). In order to maintain this population, a management regime that includes disturbances such as fire and the removal of woody invaders must be undertaken.

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Table 1. Average cover and importance value of the ground layer species encountered in the 1999 and 2001 study of the sedge meadow at the Matanzas Prairie Nature Preserve, Mason County, Illinois.

Species	1999 Average Cover	1999 I. V.	2001 Average Cover	2001 I.V.
Carex stricta	35.04	66.6	23.81	38.4
Calamagrostis canadensis	11.51	28.3	59.25	69.1
Rosa palustris	15.80	28.3	0.96	2.2
Boehmeria cylndrica	4.41	14.1	0.18	1.3
Polygonum sagittatum	2.20	14.0	0.79	4.2
Thelypteris palustris	2.78	10.5	10.17	20.3
Aster umbellatus	1.53	7.6	4.94	14.6
Lycopus virginicus	0.48	6.6	3.90	15.4
Campanula aparinoides	0.14	4.4	--	--
Scutellaria galericulata	0.79	3.8	0.91	3.6
Mimulus ringens	1.06	2.8	0.36	1.0
Leersia oryzoides	0.43	2.5	--	--
Iris shrevei	0.19	2.1	0.36	1.0
Lycopus americanus	0.18	1.6	--	--
Lysimachia thrysiflora	0.13	1.6	0.31	1.0
Epilobium leptophyllum	0.03	1.4	0.42	1.5
Agrimonia parviflora	0.02	0.9	--	--
Eupatorum maculatum	0.30	0.9	3.21	6.3
Sagittaria latifolia	0.30	0.9	--	--
Fragaria virginiana	0.06	0.6	--	--
Galium trifidum	0.01	0.5	0.11	2.2
Triadenum fraseri	--	--	0.48	5.0
Bidens coronata	--	--	0.63	3.8
Eupatorium perfoliatum	--	--	0.80	3.2
Aster firmus	--	--	0.61	1.6
Onoclea sensibilis	--	--	0.36	1.0
Solidago canadensis	--	--	0.12	0.8
Liparis loeselii	--	--	0.30	0.7
Oxypolis rigidior	--	--	0.06	0.5
Rumex altissimus	--	--	0.06	0.5
Chelone glabra	--	--	0.01	0.4
Polygonum puntatum	--	--	0.01	0.4
Totals	77.39	200.0	113.12	200.0
Average bare ground	13.11		3.15	

Table 2. Average cover and importance value of the ground layer species encountered in the wet-mesic sand prairie and the shrub prairie at the Matanzas Prairie Nature Preserve, Mason County, Illinois.

Species	SAND PRAIRIE Average Cover	I. V.	SHRUB PRAIRIE Average Cover	I. V.
Solidago canadensis	19.95	34.2	27.72	36.5
Andropogon gerardii	14.56	25.9	9.05	16.4
Carex (mostly *stricta*)	9.62	21.9	10.68	21.2
Poa pratensis	7.42	18.0	9.27	20.1
Euthamia graminifolia	7.20	17.7	9.21	17.3
Fragaria virginiana	4.52	11.0	6.02	11.5
Rubus flagellaris	4.86	10.9	8.73	14.9
Vernonia missurica	3.42	7.6	5.52	9.6
Potentilla simplex	2.25	5.3	1.20	2.1
Sorghastrum nutans	1.51	5.1	0.72	1.6
Helianthus grosseserratus	2.01	4.4	5.79	10.2
Agrimonia parviflora	1.85	4.1	3.15	4.9
Rosa palustris	2.13	4.1	3.41	5.2
Cornus drummondii	1.64	3.4	1.62	3.1
Anemone canadensis	1.20	3.1	1.80	4.0
Ulmus americana	1.05	2.8	1.62	3.1
Dichanthelium acuminatum	0.53	2.5	0.02	0.5
Cassia fasciculata	0.16	2.0	1.53	6.1
Achillea millefolium	0.21	1.8	0.01	0.2
Pycnanthemum tenuifolium	0.66	1.6	0.43	1.4
Dichanthelium clandestinum	0.37	1.1	0.60	1.0
Pycnanthemum pilosum	0.68	1.1	0.30	0.5
Salix discolor	0.75	1.1	--	--
Cyperus strigosus	0.36	1.0	0.06	0.3
Muhlenbergia mexicana	0.36	1.0	0.06	0.3
Hypericum punctatum	0.10	0.7	--	--
Apocynum sibiricum	0.07	0.5	0.37	1.0
Lycopus americanus	0.15	0.3	0.20	1.4
Solidago gigantea	0.16	0.5	0.66	1.3
Equisetum arvense	0.04	0.3	0.18	0.9
Toxicodendron radicans	--	--	0.36	0.8
Lysimachia quadriflora	0.03	0.1	0.12	0.6
Others (25 species/5 species)	1.59	4.9	0.96	2.0
Totals	91.41	200.0	111.37	200.0
Average bare ground	17.96		2.57	

APPENDIX 1

The vascular plant species encountered at Matanzas Prairie Nature Preserve are listed below by major groups, Pteridophytes (fern and fern-allies) and Spermatophytes (flowering plants), the latter divided into Monocots and Dicots. The families, genera, and species are alphabetically arranged within each group. An asterisk indicates species that have been introduced into Illinois (*). After the binomial and authority, the communities where the species were commonly encountered is given (1 = sand forest, 2 = wet sand prairie, 3 = shrub prairie, 4 = sedge meadow, 5 = cultural, 6 = open water of ditches). Collecting numbers are those of Morris (M), Feist (F), Ebinger (E), and Phillippe (P).

PTERIDOPHYTA
ASPLENIACEAE
Onoclea sensibilis L.;4; M429
EQUISETACEAE
Equisetum arvense L.;2,3; M180;
OPHIOGLOSSACEAE
Botrychium dissectum Spreng.;1,3; M606
Botrychium virginianum (L.) Sw.;1; M177
THELYPTERIDACEAE
Thelypteris palustris Schott;1,4,; M493
SPERMATOPHYTA

MONOCOTS
ALISMACEAE
Sagitaria latifolia Willd.;4;observed
COMMELINACEAE
Tradescantia ohiensis Raf.;2,3; M319
CYPERACEAE
Carex albolutescens Schw.;1; M289
Carex annectens Bickn.;1,2,5; M201
Carex blanda Dewey;1; M197
Carex brevior (Dewey) Mack.;1,2,5, M199
Carex bushii Mack.;1,2,3; M293
Carex buxbaumii Wahlenb.;1,4; M195
Carex conjuncta Boott;5; M200
Carex frankii Kunth;5; M377.1
Carex hirsutella Mack.;2,3; M414
Carex hyalinolepis Steud.;1; E28445
Carex hystricina Willd.;1; E28444
Carex jamesii Schwein.;1; M194
Carex lanuginosa Michx.;1,2,3; M198
Carex lurida Wahlenb.;4,5; M275
Carex molesta Mack.;2; M310
Carex normalis Mack.;2,3; E28448
Carex scoparia Willd.;1,2,5; M196
Carex stipata Muhl.;2,4,5; M200
Carex stricta Lam.;2,3,4; M195
Carex tenera Dewey;1; M199
Carex vulpinoidea Michx.;2,5; M270
Cyperus esculentus L.;5; M634
Cyperus filiculmis Vahl var. *macilentus* Fern.;5; M389
Cyperus schweintzii Torr.;5; M449
Cyperus strigosus L.;2,3,5; M523
Eleocharis acicularis (L.) Roem. & Schultes;5; M715
Eleocharis elliptica Kunth;4: E28630

Eleocharis smallii (L.) Britt.;4; F205
Eleocharis verrucosa (Svens.) Harms;2,3,5; M204
Scirpus atrovirens Willd.;2,5; M370
Scirpus cyperinus (L.) Kunth;5; M460
Scirpus georgianus Harper;5; E28847
Scirpus micranthus Vahl;5; M630
Scirpus pendulus Muhl.;2; M298
Scleria triglomerata Michx.;2,3; M357
IRIDACEAE
Iris shrevei Small;1,4,5; M222
JUNCACEAE
Juncus acuminatus Michx.;4; M426
Juncus canadensis J. Gay;4; M492
Juncus dudleyi Wieg.;2,3; M279
Juncus interior Wieg.;2,3; M318
Juncus marginatus Rostk.;2,5; M450
Juncus tenuis Willd.;2; M360
Juncus torreyi Coville;2,5; F212
LEMNACEAE
Lemna minor L.;6; M546
LILIACEAE
**Asparagus officinalis* L.;5; M248
Polygonatum commutatum (Schult.) A. Dietr.;1; M225
Smilacina racemosa (L.) Desf.;1; M226
ORCHIDACEAE
Liparis liliifolia (L.) Rich;1; M372
Liparis loeselii (L.) Rich.;2,4; observed
Platanthera flava (L.) Lindl. var. *herbiola* (R. Br.) Luer;5; M247
Spiranthes cernua (L.) Rich;2,4; M648
POACEAE
Agrostis alba L.;2,3; M346
Agrostis hyemalis (Walt.) BSP.;2,3; M224
Alopecurus carolinianus Walt.;5; M210
Andropogon gerardii Vitman;2,3; M554
Aristida purpurascens Poir.;2,5; M640
**Bromus tectorum* L.;5; M212
Calamagrostis canadensis (Michx.) Beauv.;2,3,4; M280
Cenchrus longispinus (Hack.) Fern.;5; M537
Dichanthelium acuminatum (Sw.) Gould & Clark;2,3; M385
Dichanthelium acuminatum (Sw.) Gould & Clark var. *lindheimeri* (Nash) Gould & Clark;2,5; M399
Dichanthelium clandestinum (L.) Gould;2,3; M368
Dichanthelium oligosanthes (Schult.) Gould;2,3,5; M257
Dichanthelium villosissimum (Nash) Freckm.;2,3,5; M302
**Digitaria sanguinalis* (L.) Scop.;5; M528
Echinochloa muricata (Beauv.) Fern.;5; M614
Elymus canadensis L.;2; E28851
Eragrostis spectabilis (Pursh) Steud.;5; M572
Eragrostis trichodes (Nutt.) Wood;5; M527
Festuca obtusa Biehler;1; M283
Glyceria striata (Lam.) Hitchc.;1; M286
Hordeum jubatum L.;5; M261
Hordeum pusillum Nutt.;5; M185
Leersia oryzoides (L.) Swartz;1,4; M622
Leersia virginica Willd.;1; M657
Muhlenbergia mexicana (L.) Trin.;2,3; F216A
Muhlenbergia schreberi J. F. Gmel.;5; M598

Panicum dichotomiflorum Michx.;5; M702
Panicum rigidulum Bosc;2;3; M530
Panicum virgatum L.;2; M416
Paspalum bushii Nash;5; M456
Paspalum ciliatifolium Michx. var. *stramineum* (Nash) Fern.;5; M456
Paspalum laeve Michx.;2; M555
**Phalaris arundinaceae* L.;4,5; M221
**Phleum pratense* L.;2; M353
**Poa compressa* L.;2,3; M306
**Poa pratensis* L.;2,3,5; M223
**Secale cereale* L.;5; M214
**Setaria faberi* Herrm.;5; M629
Sorghastrum nutans (L.) Nash;2,3; M553
Spartina pectinata Link;5; M538
Sphenopholis obtusata (Michx.) Scribn. var. *major* (Torr.) Erdman;1; M288
Sphenopholis obtusata (Michx.) Scribn. var. *obtusata*;2; M304
Tridens flavus (L.) Hitchc.;5; M575
Vulpia octoflora (Walt.) Rydb.;5; M186
POTAMOGETONACEAE
Potamogeton pusillus L.;6; M545
SMILACACEAE
Smilax hispida Muhl.;1; M596
TYPHACEAE
Typha latifolia L.;6; M582

DICOTS
ACANTHACEAE
Ruellia humilis Nutt.;2,3; M407
ACERACEAE
Acer negundo L.;1,3,5; M619
Acer saccharinum L.;1,5; M649
ANACARDIACEAE
Rhus aromatica Ait.;3; M164
Rhus glabra L.;2,3; M363
Toxicodendron radicans (L.) Kuntze;1,5; M441
APIACEAE
Cicuta maculata L.;1,5; M405
Eryngium yuccifolium Michx.;2; M410
Oxypolis rigidior (L.) Raf.;4; M490
Sanicula canadensis L.;1,2,3; M375
APOCYNACEAE
Apocynum cannabinum L.;2; M367
Apocynum sibiricum Jacq.;2,3; E28628
ASCLEPIADACEAE
Asclepias amplexicaulis Sm.;5; M259
Asclepias incarnata L.;4,5; M503
Asclepias hirtella (Pennell) Woodson;2; M472
Asclepias syriaca L.;2; M403
Cynanchum laeve (Michx.) Pers.;5; M459
ASTERACEAE
**Achillea millefolium* L.;2,3; M320
Ambrosia artemisiifolia L.;2,3; M557
Ambrosia trifida L.;1,5; M618
Antennaria neglecta Greene;2,3; M191
Aster dumosus L.;2; M214
Aster ericoides L.:2,3; M645A
Aster firmus Nees;4; M662

Aster lateriflorus (L.) Britt.;2; M656
Aster novae-angliae L.;5; M691
Aster ontarionis Wieg.;1; E29403
Aster pilosus Willd.;2,5; M588
Aster praealtus Poir.;2; E29402
Aster umbellatus Mill.;2,3,4; M468
Aster vimineus Lam.;5; E29404
Bidens bipinnata L.;1; M584
Bidens coronata (L.) Britt.;2,4,6; M583
Bidens frondosa L.;1; M690
Bidens tripartita L.;2,5; M659
Cirsium discolor (Muhl.) Spreng.;2,3; M609
Conyza canadensis (L.) Cronq.;2,3; M576
Erechtites hieracifolia (L.) Raf.;2; M654
Erigeron annuus (L.) Pers.;2,3,5; M269
Erigeron philadelphicus L.;2; M193
Erigeron strigosus Muhl.;2,3; M291
Eupatorium altissimum L.;2,3; M559
Eupatorium maculatum L.;2,3,4; M446
Eupatorium perfoliatum L.;1,4,5; M 573
Eupatorium rugosum Houtt.;1; M600
Eupatorium serotinum Michx.;2,3; M560
Euthamia graminifolia (L.) Salisb.;2,3; M561
Euthamia gymnospermoides Greene;2,3; E29217
Gnaphalium obtusifolium L.;2; M610
Helenium autumnale L.;4,5; M612
Helianthus grosseserratus Martens;2,3,4; M445
Heterotheca camporum (Greene) Shinners;5; M388
Krigia virginica (L.) Willd.;5; M217
Lactuca canadensis L.;2,3,5; M551
Liatris pycnostachya Michx.;2; M478
Rudbeckia hirta L.;2,3; M352
Solidago canadensis L.;2,3,4; M647
Solidago gigantea Ait.;1,2,3; M563
Solidago missouriensis Nutt.;2,3; M413
**Taraxacum officinale* Weber;5; M176
**Tragopogon porrifolius* L.;5; M389
Vernonia missurica Raf.;2,3; M469
BETULACEAE
Betula nigra L.;1,3; M163
BORAGINACEAE
Hackelia virginiana (L.) I. M. Johnston;1; M436
BRASSICACEAE
**Barbarea vulgaris* R. Br.;2; M184
Cardamine pensylvanica Muhl.;5; M183
Lepidium virginicum L.;5; M216
Rorippa sessiliflora (Nutt.) Hitchc.;5; M205
Rorippa islandica (Oeder) Borbes var. *fernaldiana* Butt. & Abbe;5; M265
CAESALPINIACEAE
Cassia fasciculata Michx.;2,3; M475
CAMPANULACEAE
Campanula americana L.;1; M497
Campanula aparinoides Pursh;2,4; M521
Lobelia siphilitica L.;1; M574
Lobelia spicata Lam.;2,3; M294
Triodanis perfoliata (L.) Nieuwl.;2,3; M256
CAPRIFOLIACEAE

**Lonicera maackii* (Rupr.) Maxim.;5; M170
Sambucus canadensis L.;3,5; M250
CARYOPHYLLACEAE
Cerastium nutans Raf.;5; M181
**Dianthus armeria* L.;2,3,5; M351
**Holosteum umbellatum* L.;5; M207
**Saponaria officinalis* L.;5; M487B
Silene antirrhina L.;2,3; M206
CERATOPHYLLACEAE
Ceratophyllum demersum L.;6; M717
CHENOPODIACEAE
Chenopodium album L.;5; M533
Chenopodium standleyanum Aellen.;1; M678
CONVOLVULACEAE
Calystegia sepium (L.) R. Br.;4,5; M397
**Ipomoea hederacea* (L.) Jacq.;5; M697
Ipomoea lacunosa L.;1,5; M635
CORNACEAE
Cornus drummondii C.A. Mey.;1,2,3; M356
Cornus obliqua Raf.;1,2,3,4,5; M251
CUSCUTACEAE
Cuscuta pentagona Engelm.;4,5; M696
EBENACEAE
Diospyros virginiana L.;1,3; M252
ELAEAGNACEAE
**Eleagnus umbellata* Thunb.;3,5; M709
EUPHORBIACEAE
Acalypha gracilens Gray;2; M216B
Acalypha rhomboidea Raf.;1,4; M436
Euphorbia corollata L.;2,3; M408
Poinsettia dentata (Michx.) Kl. & Garcke;5; M621
FABACEAE
Desmodium canadense (L.) DC.;2,3; M567
Desmodium sessilifolium (Torr.) Torr. & Gray;2; M565
Desmodium paniculatum (L.) DC.;1,2; M566
**Kummerowia stipulacea* (Maxim.) Makino;5; M616
Lespedeza capitata Michx.;2,3; M549
**Melilotus officinalis* (L.) Pallas;2,5; M258
Strophostyles helvola (L.) Ell. var. *helvola*;5; M458
**Trifolium hybridum* L.;5; M359
FAGACEAE
Quercus palustris Muenchh.;5; M548
Quercus velutina Lam.;5; M653
GERANIACEAE
Geranium carolinianum L.;5; M262
GROSSULARIACEAE
Ribes missouriense Nutt.;1; M171
HYPERICACEAE
Hypericum canadense L.;5; M536
Hypericum majus (Gray) Britt.;5; M452
Hypericum mutilum L.;5; M626
Hypericum punctatum Lam.;2,3; M439
Triadenum fraseri (Spach) Gl.;4; M484
JUGLANDACEAE
Carya illinoensis (Wang.) K. Koch;1; M707
LAMIACEAE
Lycopus americanus Muhl.;1,2,4; M424

Lycopus rubellus Moench;4; M504
Lycopus virginicus L.;4; M518
Mentha arvensis L.;1,4; M604
Monarda punctata L.;5; M522
**Prunella vulgaris* L.;1,5; M448
Pycnanthemum tenuifolium Schrad.;2,3; M393
Pycnanthemum pilosum Nutt.;2,3,5; M479
Pycnanthemum virginianum (L.) Dur. & Jacks.;1; M438
Scutellaria galericulata L.;2,4; M364
Scutellaria lateriflora L.;1,2,4; M364
Stachys palustris L. var. *homotricha* Fern.;2,3; M383
Teucrium canadense L. var. *virginicum* (L.) Eat.;5; M455
LAURACEAE
Sassafras albidum (Nutt.) Nees;1,3; M165
LYTHRACEAE
Lythrum alatum Pursh;2,5; M366
Rotala ramosior (L.) Koehne;5; M628
MENISPERMACEAE
Menispermum canadense L.;1; M605
MOLLUGINACEAE
**Mollugo verticillatus* L.;5; M526
MORACEAE
**Morus alba* L.;1,5; M172
NYCTAGINACEAE
**Mirabilis nyctaginea* (Michx.) MacM.;2,5; M461
OLEACEAE
Fraxinus pennsylvanica Marsh.;1,3; M665
ONAGRACEAE
Circaea lutetiana Aschers. & Magnus ssp. *canadensis* (L.);1; M597
Gaura biennis L.;2; M470
Epilobium coloratum Biehler;2,3; M516
Epilobium leptophyllum Raf.;4; M488
Ludwigia alternifolia L.;2,3; M442
Ludwigia palustris (L.) Ell.;4,6; M512
Oenothera biennis L.;2,3; M552
Oenothera rhombipetala Nutt.;5; M457
Oenothera laciniata Hill;5; M215
OXALIDACEAE
Oxalis dillenii Jacq.;2; M211
Oxalis stricta L.;5; M380
PHYTOLACCACEAE
Phytolacca americana L.;1; P26397
PLANTAGINACEAE
Plantago virginica L.;5; M178
PLATANACEAE
Platanus occidentalis L.;2,5; M636
POLEMONIACEAE
Phlox glaberrima L.;4; M430
POLYGALACEAE
Polygala cruciata L.;2; M487A
Polygala sanguinea L.;2; M423
POLYGONACEAE
Polygonum amphibium L.;2,4; M 513
Polygonum cristatum Engelm. & Gray;1; M666
**Polygonum hydropiper* L.;5; M624
Polygonum hydropiperoides Michx.;6; E28878
Polygonum lapathifolium L.;6; M615

Polygonum pensylvanicum L.;2,5; M451
**Polygonum persicaria* L.;5,6; M508
Polygonum punctatum Ell.;1,2,4,5,6; M507
Polygonum sagittatum L.;4; M515
Polygonum scandens L.;1; M602
Polygonum virginianum L.;1; M496
**Rumex acetosella* L.;5; M187
Rumex altissimus Wood;4; E28634
Rumex orbiculatus Gray;5; M511
**Rumex crispus* L.;2,5; M263
PRIMULACEAE
Lysimachia lanceolata Walt.;2; M365
Lysimachia quadriflora Sims;2,3,4; F215
Lysimachia thyrsiflora L.;4; F202
RANUNCULACEAE
Anemone canadensis L.;2,3; M175
Anemone virginiana L.;2; M347
Ranunculus abortivus L.;1,5; M189
Ranunculus longirostris Godr.;6; M547
RHAMNACEAE
**Rhamnus cathartica* L.;1,3; M190
**Rhamnus frangula* L.;1,2,3; M651
ROSACEAE
Agrimonia parviflora Ait.;1,2,3,4; M495
Fragaria virginiana Duchesne;2,3,4; M174
Geum canadense Jacq.;1; M381
**Potentilla norvegica* L.;5; M395
**Potentilla recta* L.;2,5; E28642
Potentilla simplex Michx.;2,3; M188
Prunus serotina Ehrh.;1,5; M167
**Rosa multiflora* Thunb.;2,5; M326
Rosa palustris Marsh.;2,3,4; M299
Rosa setigera Michx.;3,5; M406
Rubus allegheniensis Porter;2,3,5: E28436
Rubus flagellaris Willd.;2,3; M220
Rubus occidentalis L.;5; M404
Rubus pensylvanicus Poir.;2; M327
RUBIACEAE
Cephalanthus occidentalis L.;3,4; M421
Diodia teres Walt.;5; M529
Galium aparine L.;1; M192
Galium circaezans Michx.;1; M290
Galium concinnum Torr. & Gray;4; F201
Galium obtusum Bigel.;2,3; M313
Galium trifidum L.;2,4; E28436
Galium triflorum Michx.;1; M373
RUTACEAE
Zanthoxylum americanum Mill.;1,3; M166
SALICACEAE
Populus deltoides Marsh.;1,2; M550
Salix discolor Muhl.;1,2,3,4,5; M274
Salix exigua Nutt.;1,3,5; M168
Salix nigra Marsh.;1; M169
SAXIFRAGACEAE
Penthorum sedoides L.;6; M580
SCROPHULARIACEAE
Agalinis aspera (Dougl.) Britt.;2,3; M483

Agalinus purpurea (L.) Pennell;2,3; F207
Chelone glabra L.;4; M577
Gratiola neglecta Torr.;1,2,4; M311
Lindernia dubia (L.) Pennell var. *anagallidea* (Michx.) Cooperrider;5; M531
Mimulus ringens L.;4; M501
Pedicularis lanceolata Michx.;2,4; M571
Penstemon pallidus Small;2,3; M173
Tomanthera auriculata (Michx.) Raf.;2; M642
**Verbascum thapsus* L.;5; E28884
**Veronica arvensis* L.;5; M208
Veronica peregrina L.;5; M209
SOLANACEAE
Physalis heterophylla Nees;2,3; M249
Solanum carolinense L.;5; M401
Solanum ptycanthum Dunal;1; M676
ULMACEAE
Ulmus americana L.;2,3; observed
URTICACEAE
Boehmeria cylindrica (L.) Sw.;1,4; M428
Laportea canadensis (L.) Wedd.;1; M608
Parietaria pensylvanica Muhl.;4; M277
Pilea pumila (L.) Gray;1; M595
VERBENACEAE
Phyla lanceolata (Michx.) Greene;4,5; M422
Verbena hastata L.;2,3,4,5; M391
Verbena stricta Vent.;5; M392
VIOLACEAE
Viola lanceolata L.;2; M179
Viola pratincola Greene;1; M219
**Viola rafinesquii* Greene;2; M182
Viola sagittata Ait.;2; observed
Viola sororia Willd.;2,3; M218
VITACEAE
Ampelopsis cordata Michx.;5; E28887
Parthenocissus quinquefolia (L.) Planch.;1; M710
Vitis riparia Michx.;1,5; M254
Vitis aestivalis Michx.;1,5; M705

WHITE OAK CREEK WOODS NATURAL AREA, MASON COUNTY, ILLINOIS

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ABSTRACT: *Quercus alba* (white oak), a dominant tree of mesic and wet-mesic forests in Illinois, is uncommon in the extensive sand deposits of the state. In the Kankakee sand deposits of northeastern Illinois white oak sometimes occurs on lower dune slopes and swales. This species, however, is rarely found in the Mississippi and Illinois River sand deposits. An exception is at White Oak Creek Woods Natural Area near the Illinois River in Mason County. Located on a flat upland terrace, white oak dominates the overstory where it accounts for nearly 70% of the importance value. *Quercus velutina* (black oak), *Prunus serotina* (black cherry), and *Sassafras albidum* (sassafras) account for most of the remaining stems. No oak saplings were found in the natural area, probably the result of a closed canopy due to past fire suppression.

INTRODUCTION

Quercus alba L. (white oak), an important forest tree throughout eastern United States, is common from Maine to Michigan and Minnesota, and south to eastern Texas and northern Florida (Gleason and Cronquist 1991). Throughout the northern half of its range, this species is a leading dominant of mesic and wet-mesic oak forests, woodlands, and savannas. In these communities white oak is commonly associated with *Quercus velutina* Lam. (black oak), *Quercus rubra* L. (red oak), and various species of *Carya* spp. (hickories)(Braun 1950, Ebinger 1997, Tyrrell et al. 1998).

White oak is well adapted to mesic habitats in Illinois, occurring in upland forests, open woodlands, prairie groves, and scattered trees associated with prairies. Known from all Natural Divisions of Illinois, it is commonly listed as a component of many different plant communities (Schwegman 1973, Mohlenbrock and Ladd 1978, White and Madany 1978). It is, however, not a common species in the sand deposits of the state.

Sand deposits account for nearly 5% of the land surface of Illinois and generally occur on glacial outwash plains associated with erosional events of Wisconsin glaciation in the northern half of the state (Schwegman 1973, Willman and Frye 1970, King 1981). Of the large sand deposits within Illinois, only the Kanakakee Sand Area Section of the Grand Prairie Division consistently has communities in which white oak is a common component (Schwegman 1973).

In the Illinois River Section of the Mississippi River and Illinois Rivers Sand Areas Natural Division white oak is rarely present. The authors know of only one forest community of this natural division in which white oak is a common overstory component. The purpose of this study was to determine the composition and structure of this white oak

dominated forest and compares the results with other sand forests in Illinois.

DESCRIPTION OF THE STUDY SITE

White Oak Creek Woods Natural Area is located in Mason County, about 6 km south of Havana, Illinois (SE1/4 NW1/4 S23 T21N R9W). The site, about 2 ha in size, is located on a sandy upland terrace about 500 m west of the Illinois River immediately south of White Oak Creek. The soils are excessively drained Plainfield sand (Calsyn 1995), part of the dune and swale topography known as the Parkland Formation (Willman and Frye 1970).

Little is known about the history of this small tract of timber. This small tract, however, as well as the land north of White Oak Creek, was designated "grade B" dry sand forest by the Illinois Natural Areas Inventory (White 1978). Selective logging during the 1980 modified the area north of White Oak Creek and it is now designated "grade C" dry sand forest (Lerczak 2000). Registered as an Illinois Natural Heritage Landmark since 1983, it is presently designated the Speckman-Stelter Woods Land and Water Reserve by the Illinois Nature Preserves Commission (Lerczak 2000).

Based on weather data from Havana, mean annual precipitation is 96.0 cm, with May having the highest rainfall (11.3 cm). Mean annual temperature is 10.8°C with the hottest month being July (average of 24.6°C), and the coldest January (average of -5.0°C). Frost-free days range from 140 to 206, with the average being 173 day per year (Midwestern Regional Climate Center 2004).

METHODS

During late summer of 2004, a 75 m by 125 m section of the 2 ha natural area was surveyed by dividing the areas into 15 contiguous quadrates 25 m on a side. All living and dead-standing woody individuals $\geq$10.0 cm dbh were identified and their diameters recorded. From this data, living-stem density (stems/ha), basal area (m^2/ha), relative density, relative dominance, importance value (IV), and average diameter (cm) were calculated for each species. Determination of the IV follows the procedure used by McIntosh (1957), and is the sum of the relative density and relative dominance (basal area). Dead-standing density (stem/ha) and basal area (m^2/ha) was also determined.

Woody understory composition and density (stems/ha) was determined using nested circular plots 0.0001, 0.001, and 0.01 ha in size located at about 15 meter intervals along line transects within the study area (20 plots). Four additional 0.0001 ha circular plots were located 7 m from the center points of each of the 20 plot centers along cardinal compass directions (100 plots). In the 0.0001 ha plots, woody seedlings ($\leq$50 cm tall) were counted; in the 0.001 ha circular plots small saplings (>50 cm tall and <2.5 cm dbh) were recorded; and in the 0.01 ha circular plots large saplings (2.5-9.9 cm dbh) were tallied.

RESULTS

Only 10 species were present in the overstory (Table 1). White oak dominated the larger diameter classes with an IV of 144.2 (200 possible), and an average diameter of 53.4 cm. Most of the larger white oaks had an open-grown appearance with large branches or branch scares

within 4 m of the ground. Black oak, also restricted to the higher diameter classes, was second in IV (12.7), and had an average diameter of 71.3 cm. The remaining trees were mostly in the 10-29 cm diameter classes. Dead-standing individuals averaged 11.7 stems/ha with an average basal area of 2.641 m^2/ha, all being white and black oaks.

The woody understory was relatively sparse, being very open in many areas (Table 2). Throughout the woods *Sassafras albidum* (Nutt.) Nees (sassafras) dominated the seedling and sapling categories with 4300 seedlings/ha, 1600 small saplings/ha, and 545 large saplings/ha. White oak seedlings were also common, but no oak saplings were encountered.

DISCUSSION

Although the forests of the Speckman-Stelter Woods Land and Water Reserve and surrounding land were never clear-cut, they undoubtedly are now very different today compared to the early 1800s. According to Lerczak (2000), Ms. Stelter, the present owner of the property, recalled her great grandfather stating that it was possible to drive a wagon through the woods in the 1840s, an indication of the openness of the woods were at that time. Also mentioned was that many of the oaks were present as grubs which occurs when oaks are continually top-killed by frequent fires (Taft 1997).

The present appearance of White Oak Creek Woods compared to 150 years ago is due to a reduced fire frequency followed by a total absence of fire in recent decades (Taft 1997). In presettlement times frequent fires maintained much of this mesic to wet-mesic oak cover type, particularly along the western edge of its range (Ebinger and McClain 1991, McClain and Elzinga 1994). In general oaks are well adapted to fire due to their thick bark and ability to reproduce by sprouts, giving them a competitive advantage in areas of high fire frequencies. Oak densities in this presettlement landscape was dictated by fire frequency and intensity, ranging from low densities in savannas and woodlands that burned hot and frequently, to higher densities in closed forests where surface fires burned cooler and were less frequent (Anderson 1991, Abrams 1992).

The vegetation of White Oak Creek Woods Natural Area was surveyed in 1976 by the Illinois Natural Areas Inventory (INAI)(White 1978). At that time parts of the woods were designated "grade B" old-growth dry sand forest and tree density averaged 292 stems/ha with a basal area of 25.4 m^2/ha. Black oak was the dominant overstory species with 100 stems/ha and a basal area of 17.0 m^2/ha. *Ulmus americana* L. (American elm), white oak, and sassafras followed in importance. The area surveyed by the INAI, however, was to the north of White Oak Creek, not the small section to the south of White Oak Creek examined during the present survey.

No other forested areas examined in the Illinois River sand deposits contained white oak. Most were closed canopy dry sand forests on dune deposits where black oak and *Quercus marilandica* Muench. (blackjack oak) were the leading dominants along with a few hickory species in low numbers (Jenkins et al. 1991, Coates et al. 1992, McClain et al. 2002). One closed forest, Barton Woods, located on a terrace of Salt Creek in Mason County, is dominated by *Celtis occidentalis* L. (hackberry) and *Quecus macrocarpa* Michx. (bur oak) (McClain et al. 1993). In this wet-mesic forest white oak was not encountered though many mesic species

were present: *Gleditsia triacanthos* L. (honey locust), American elm, *Platanus occidentalis* l. (sycamore), *Ulmus rubra* Muhl. (slippery elm), *Juglans nigra* l. (black walnut), and *Quercus bicolor* Willd. (swamp white oak).

Rogers and Anderson (1979) used General Land Office survey records to determine the presettlement vegetation of Mason County in 1821-1824. In all community classes (prairie, savanna, open forest, and closed forest) black oak was the dominant woody species and usually accounted for more than half of the IV. Blackjack oak was second in IV in the open canopy communities (prairie and savanna) while in open and closed forests hickories and *Acer* spp. (maples) were second and third in importance. White oak was not common, but was occasionally recorded in savannas, and open and closed forests. These forests were mostly on the western edge of the county adjacent to the Illinois River and its backwater lakes. Decreased fire frequency in this region may have permitted the establishment of mesic to dry-mesic forest communities.

The only other sand area of Illinois where white oak is an occasional component of the vegetation is the Kankakee Sand Area Section of the Grand Prairie Natural Division. White oak is a component of dry-mesic sand savanna communities that exist on the lower slopes of dunes and swales (McDowell et al. 1983, Johnson and Ebinger 1992). On these sites the vegetation is an open savanna community with a herbaceous understory of native prairie species (Johnson and Ebinger 1995). In these communities periodic fire was commonly use to maintain an open overstory.

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Table 1. Density by diameter classes (stems/ha), basal area (m^2/ha), relative density, relative dominance (basal area), importance value and average diameter (cm) of woody overstory species at White Oak Creek Natural Area, Mason County, Illinois.

Species	10-19	20-29	30-39	40-49	50-59	60-69	70+	Den. #/ha	Basal Area m^2/ha	Rel. Den.	Rel. Dom.	I. V.	Av. Diam. (cm)
Quercus alba	--	--	11.7	29.9	35.2	24.5	4.3	105.6	24.577	58.6	85.6	144.2	53.4
Quercus velutina	--	--	--	--	1.1	1.1	4.3	6.5	2.611	3.6	9.1	12.7	71.3
Prunus serotina	18.1	2.1	--	--	--	--	--	20.2	0.284	11.2	1.0	12.2	12.9
Sassafras albidum	17.1	--	--	--	1.1	--	--	18.2	0.466	10.0	1.6	11.6	14.1
Robinia pseudoacacia	9.6	2.1	--	--	--	--	--	11.7	0.240	6.5	0.8	7.3	15.6
Morus alba	8.5	--	--	--	--	--	--	8.5	0.094	4.7	0.4	5.1	11.8
Maclura pomifera	2.1	--	1.1	1.1	--	--	--	4.3	0.322	2.4	1.1	3.5	28.0
Ulmus americana	2.1	1.1	--	--	--	--	--	3.2	0.098	1.8	0.4	2.2	18.2
Celtis occidentalis	1.1	--	--	--	--	--	--	1.1	0.010	0.6	--	0.6	10.9
Juglans nigra	1.1	--	--	--	--	--	--	1.1	0.013	0.6	--	0.6	12.3
Totals	59.7	5.3	12.8	31.0	37.4	25.6	8.6	180.4	28.715	100.0	100.0	200.0	

Table 2. Density (individuals/ha) of woody understory species in a woodland community at White Oak Creek Natural Area, Mason County, Illinois.

Species	Seedlings	Small Saplings	Large Saplings
Sassafras albidum	4300	1600	545
Celtis occidentalis	1700	100	25
Quercus alba	1100	--	--
Quercus velutina	800	--	--
Carya texana	300	200	95
Ulmus americana	300	--	15
Prunus serotina	200	100	375
Morus alba	100	--	45
Cercis canadensis	100	--	20
Asimina triloba	100	--	--
Carya tomentosa	--	50	--
Ulmus rubra	--	--	145
Robinia pseudoacacia	--	--	75
Crataegus mollis	--	--	5
Tilia americana	--	--	5
Fraxinus lanceolata	--	--	5
Juglans nigra	--	--	5
Cornus drummondii	200	200	10
Toxicodendron radicans	7700	--	--
Rubus allegheniensis	1200	--	--
Ribes missouriense	900	--	--
Totals	19000	2250	1370

Herbaceous plant succession at Sand Prairie-Scrub Oak Nature Preserve, Mason County, Illinois

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ABSTRACT: The herbaceous vegetation was studied at one-, three-, and twelve-year intervals following clearing of a pine plantation at the Sand Prairie-Scrub Oak Nature Preserve, Mason County, Illinois. The annual species *Setaria faberii* (giant foxtail), *Bidens bipinnata* (Spanish needles), and *Digitaria sanguinalis* (crabgrass) dominated the first year. The perennial *Dichanthelim villosissimum* (hairy panic grass) along with the non-native *Mollugo verticillata* (carpetweed) was prominent the third year while *Diodia teres* (buttonweed) and *Eragrostis trichodes* (sand love grass) dominated the twelfth year. Two dominants of mature sand prairie, *Schizachyrium scoparium* (little bluestem) and *Tephrosia virginiana* (goat's rue), were not present within the study area.

INTRODUCTION

Sand prairie communities are present in Illinois along the Green, Illinois, Kankakee, and Mississippi rivers, and Lake Michigan (Gleason 1910, Schwegman et al. 1973, Vestal 1913). Due to their arid nature they were the lasts of the extensive Illinois prairies to be converted to agriculture. In the early 1900s, thousands of acres of sand prairie still remained (Hart and Gleason 1907, Sampson 1921). With the advent of center pivot irrigation, much of the remaining sand prairie was converted to agriculture by 1960. The areas remaining were unsuitable for agriculture due to extensive sand dunes, large areas of actively moving sand, or depressions too difficult to drain.

The most extensive of the states' sand deposits is associated with the Illinois River in central Illinois. In these deposits the Illinois Department of Natural Resources, in cooperation with the Illinois Nature Preserves Commission, purchased and established several large nature preserves and state forests. One of the largest is Sand Prairie-Scrub Oak Nature Preserve (SP-SONP). At the time of purchase in 1969, this site was a mixture of remnant prairie, savanna, forest, and abandoned agricultural fields.

The opportunity to study the early stages of secondary plant succession at the SP-SONP occurred in the fall of 1992 when a large *Pinus banksiana* Lamb. (jack pine) plantation was cleared. This dense plantation was devoid of native woody and herbaceous vegetation, and pine removal exposed several hectares of bare mineral soil. The purpose of this study was to document plant succession changes over a period of twelve years.

DESCRIPTION OF THE STUDY AREA

SP-SONP is s 590 ha site located between the villages of Bath and Kilbourne (T20N, R9W, Sections 13, 14, 23, 26, of the 3rd PM), Mason County, Illinois. Part of the Illinois River Section of the Illinois and Mississippi River Sand Areas Natural Division (Schwegman et al.

1973), these sands were deposited by the Kankakee Torrent approximately 14,500 years ago (Willman and Frye 1970). Subsequent wind action created the dune and swale topography characteristic of the Parkland Formation (Willman and Frye 1970). The soils consist of about 95 % sand, 4 % silt, and 1 % clay. Soil pH ranges from 5.1 to 5.3 from prairie to open forest, and soils are low in organic matter and nitrogen (Benjamin et al. 1989).

The SP-SONP was a mixture of remnant prairie, sand forest, and savanna, tree plantations, and recently abandoned agricultural fields when purchased by the state. The only management activities have been prescribed burning for woody species control and invasive exotic species removal, mostly *Robinia psuedoacacia* L. (black locust). Abandoned agricultural fields have been allowed to re-vegetate naturally, and no plant propagules have been added.

The climate at SP-SONP is continental with warm summers and cold winters. Based on weather data from Havana, Illinois, about 12 km north of the site, mean annual precipitation is 96.0 cm, with May having the highest rainfall (11.3 cm). Mean annual temperature is 10.8° C, with July as the hottest month (average of 24.6° C), and the coldest being January (average of -5.0° C). Frost-free days range from 140 to 206, with the average being 173 days per year (Midwestern Regional Climate Center 2004).

METHODS

The study site was visited during September of 1993, 1995, and 2004. The ground layer vegetation was studied by aligning two randomly located transects, 25 m long, within the study area. Along each transect, 1/4 m^2 quadrates were located at 1 m intervals (n=25/transect), odd-numbered quadrates to the right even-numbered to the left. A random numbers table was used to determine the number of meters (0 to 9) a quadrate was located from the transect line. Cover was determined by using the Daubenmire cover class system (Daubenmire 1959) as modified by Bailey and Poulton (1968). Importance value (IV) for ground layer species was determined by summing relative cover and relative frequency. Only frequency of species was recorded the first year of the study.

Voucher specimens of each plant species were collected, identified, and deposited in the Stover-Ebinger Herbarium of Eastern Illinois University, Charleston, Illinois (EIU). Criteria for designating non-native species followed Mohlenbrock (2002), and Gleason and Cronquist (1991), while nomenclature follows Mohlenbrock (2002).

RESULTS

Eleven herbaceous species were present in sample plots during the first year of study, nine annuals and two perennials, four being non-native taxa (Table 1.). The most frequently encountered species were *Bidens bipinnata* L. (Spanish needles), *Setaria faberii* F. Herrm. (giant foxtail), *Digitaria sanguinalis* (L.) Scop. (crabgrass), and *Diodia teres* Walt. (buttonweed) (Table 1).

The perennial *Dichanthelium villosissimum* (Nash.) Freckm. (hairy panic grass) was well established throughout the site by the third year. Annual species, such as Spanish needles and giant foxtail, had declined significantly, but the exotic annual *Mollugo verticillata* L.

(carpetweed) was second in importance. Seedlings of *Quercus velutina* Lam. (black oak), along with 23 other species were present in the plots. Of this total, 16 were perennial sand prairie species (Table 1).

Twenty-seven species were present in the plots during the twelth year, including 16 native perennial sand prairie species (Table 1). Though buttonweed was the dominant species, the native perennial *Eragrostis trichodes* (Nutt.) Wood (sand love grass) was second followed by *Opuntia humisfusa* (Raf.) Raf. (eastern prickly pear cactus), *Aristida desmantha* Trin. & Rupr. (three-awn grass), and hairy panic grass.

DISCUSSION

Abandoned agricultural fields located on sand deposits are colonized by native vegetation within a relatively short amount of time (McClain et al. 2005). During this twelve-year study, the herbaceous vegetation changed from non-native annuals to long-lived perennial sand prairie species (Table 1). One perennial, sand love grass, is an aggressive species that has dominated abandoned agricultural fields at SP-SONP for more than 60 years (McClain et al. 2005).

Though the vegetation of the study site currently consists of native sand prairie species, the composition is not similar to that of mature dry sand prairie. The most important grasses in mature dry sand prairie are *Schizachyrium scoparium* (Michx.) Nash. (little bluestem) and hairy panic grass, while *Tephrosia virginiana* (L.) Pers. (goat's rue), eastern prickly pear cactus, and *Ambrosia psilostachya* DC. (western ragweed) are usually among the top five in importance (Table 1).

Because no data are available on sand prairie restorations in Illinois, it is not known if planting seeds or plants of characteristic sand prairie species, such as little bluestem and goat's rue, will reduce the time required for their establishment. Prairie restoration guides contain little information on restoring sand prairies and most attempts to recreate prairie having taken place on loam soils (Packard and Mutel 1997, McClain 2003). Current management strategies allow for natural re-establishment of native flora within the old fields at SP-SONP.

The time required for prairie flora to invade abandoned fields at SP-SONP and become floristically similar in composition to native prairie is substantial. In a related study at SP-SONP, the flora of a 60-year old abandoned field still does not closely resemble the composition of mature remnant prairies (McClain et al. 2005). The reasons for this lengthy time requirement are not completely understood, but these results are consistent with other studies (Curtis 1959). The slow colonization of abandoned agricultural fields by dominant dry sand prairie flora may be due to heavy, gravity-dispersed seeds (Curtis 1959), disruption of the microrhizal community (Benjamin et al. 1989), or absence of a dispersal agent.

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Table 1. Frequency (%), average cover, and importance value of the vascular plant species encountered in a mature sand prairie, a 12-year old successional field and a 3-year old successional field, and the frequency of species encountered in bare ground the year the area was bull-dozed to remove a pine plantation at Sand Prairie-Scrub Oak Nature Preserve, Mason County, Illinois

	MATURE PRAIRIE			12-YEAR OLD FIELD			3-YEAR OLD FIELD			BARE
Species	Freq. %	Av. Cover	I.V.	Freq. %	Av. Cover	I.V.	Freq. %	Av. Cover	I.V.	Freq. %
Schizachyrium scoparium	100	46.35	79.4	--	--	--	--	--	--	--
Dichanthelium villosissimum	94	9.22	30.6	40	2.39	15.7	98	21.02	63.0	--
Tephrosia virginiana	74	10.51	28.3	--	--	--	--	--	--	--
Ambrosia psilostachya	68	6.74	22.2	8	0.48	3.1	2	0.30	1.0	--
Opuntia humifusa	56	3.12	15.2	46	4.88	24.8	40	3.07	13.8	--
Eragrostis spectabilis	24	0.91	6.0	6	0.13	1.6	--	--	--	--
Cyperus schweinitzii	26	0.33	5.6	12	0.06	2.6	2	0.06	0.4	--
Calamagostis longifolia	18	0.09	3.7	--	--	--	--	--	--	--
Crotonopsis linearis	10	0.05	2.1	4	0.02	0.9	98	2.33	22.3	--
Oenothera rhombipetala	8	0.19	1.8	--	--	--	2	0.06	0.4	--
Cyperus grayoides	8	0.09	1.7	2	0.01	0.4	38	0.54	7.9	58
Carex muhlenbergii	4	0.12	1.0	8	0.19	2.2	18	1.21	5.8	--
Aristida tuberculosa	4	0.07	0.9	--	--	--	--	--	--	--
Andropogon gerardii	2	0.06	0.5	--	--	--	--	--	--	--
Bouteloua gracilis	2	0.06	0.5	--	--	--	--	--	--	--
Pseudognaphalium obtusifolium	2	0.06	0.5	--	--	--	--	--	--	--
Diodia teres	--	--	--	84	7.97	42.1	14	0.90	4.5	38
Eragrostis trichodes	--	--	--	54	6.21	30.5	6	0.90	3.1	--
Aristida desmantha	--	--	--	78	1.72	21.2	--	--	--	--
Paspalum bushii	--	--	--	24	2.35	12.3	2	0.01	0.3	--
Conyza canadensis	--	--	--	26	1.25	9.2	2	0.06	0.4	--
Triplasis purpurea	--	--	--	28	0.68	7.8	6	0.18	1.5	--
Rhus glabra	--	--	--	10	1.47	6.6	16	2.40	8.0	--
Croton glandulosus	--	--	--	14	0.07	3.0	92	2.20	21.0	12
Chamaechrista fasciculata	--	--	--	4	0.60	2.7	--	--	--	--
Rubus allegheniensis	--	--	--	4	0.60	2.7	6	0.42	2.1	--
Cyperus lupulinus	--	--	--	10	0.05	2.2	--	--	--	--

Leptoloma cognatum	--	--	--	4	0.36	1.9	--	--	--	--
*Mollugo verticillata	--	--	--	8	0.04	1.7	86	8.18	32.9	--
Digitaria filiformis	--	--	--	6	0.03	1.3	--	--	--	--
*Setaria faberi	--	--	--	4	0.07	1.0	20	0.25	4.1	60
Froelichia gracilis	--	--	--	4	0.02	0.9	--	--	--	--
Carex tonsa	--	--	--	2	0.06	0.6	--	--	--	--
Lespedeza capitata	--	--	--	2	0.06	0.6	--	--	--	--
Froelichia floridana	--	--	--	2	0.01	0.4	2	0.06	0.4	--
Solanum ptychanthum	--	--	--	--	--	--	10	1.02	3.9	--
Quercus velutina	--	--	--	--	--	--	4	0.60	2.1	--
Chenopodium desiccatum	--	--	--	--	--	--	2	0.06	0.4	--
Solanum carolinense	--	--	--	--	--	--	2	0.06	0.4	--
Physalis heterophylla	--	--	--	--	--	--	2	0.01	0.3	--
Commelina erecta	--	--	--	--	--	--	--	--	--	4
Bidens bipinnata	--	--	--	--	--	--	--	--	--	72
*Digitaria sanguinalis	--	--	--	--	--	--	--	--	--	56
Dichanthelium acuminatum	--	--	--	--	--	--	--	--	--	30
Fimbristylis autumnalis	--	--	--	--	--	--	--	--	--	2
*Ipomoea hederacea	--	--	--	--	--	--	--	--	--	2
*Setaria viridis	--	--	--	--	--	--	--	--	--	2
Totals		77.97	200.0		31.78	200.0		45.90	200.0	
Average bare ground and litter		27.16			66.85			51.55		

Floristic composition and structure of two dry sand prairies at Sand Ridge State Forest, Mason County, Illinois

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ABSTRACT - Burns and Quiver prairies are dry sand prairies in small forest openings on ridges and swales of large stabilized dunes at Sand Ridge State Forest, Mason County, Illinois. Dominant species were nearly identical on both prairies. *Schizachyrium scoparium* (little bluestem) had an importance value of 40.1 on Quiver Prairie and 35.7 on Burns Prairie. *Tephrosia virginiana* (goat's-rue), *Opuntia humifusa* (common prickly pear), and *Ambrosia psilostachya* (western ragweed) were among the top five species on both prairies. Other common grasses were *Dichanthelium villosissimum* (hairy panic grass) on both prairies and *D. depauperatum* (panic grass) on Quiver Prairie.

INTRODUCTION

At the time of settlement by European man prairie vegetation covered about 60% of Illinois (Iverson et al. 1991). Most was tall-grass, black soil prairie common in the prairie peninsula of northeastern Illinois, though extensive tall grass prairies were also common in many parts of the state (Transeau 1935, Schwegman 1973). Depending upon soil and topography, other prairie types were common, including loess hill prairies, glacial till prairies, sand prairies, and gravel prairies (Schwegman 1973).

Sand prairies were relatively common in the northern half of Illinois, mostly on outwash plains that resulted from erosional events associated with Wisconsin glaciation (Willman and Frye 1970, King 1981). The most extensive of these sand deposits occurs in central Illinois in Mason and Cass counties (Gleason 1910, Schwegman 1973, Willman 1973). These deposits were formed about 14,500 years ago when glacial moraines and ice dams were breached, resulting in a flood known as the Kankakee Torrent. This flood removed extensive deposits of sand and gravel from glacial lakes in northeastern Illinois and adjacent Indiana. Most of this sand and gravel was deposited when the waters of the Kankakee Torrent slowed upon entering the broad lowlands of the Illinois River. These extensive sand deposits were then reworked by winds creating the present dune and swale topography.

Since early studies of Gleason (1910) very little has been published concerning the structure and composition of the ground layer vegetation of Illinois sand deposits. Though greatly modified by human activity, a few nature preserves and other high quality natural areas still occur in these sand deposits. The present study was undertaken to determine vascular plant species composition, vegetation structure, and floristic quality of two of the larger remaining dry sand prairie openings at Sand Ridge State Forest.

DESCRIPTION OF THE STUDY SITE

Sand Ridge State Forest is located in northwestern Mason County about 21 km northeast of Havana, and just west of Forest City, Illinois (parts of townships T22N R7W and T23N R7W). This 3,035 ha (11.7 sq. miles) state forest lies within the Illinois River Section of the Mississippi River and Illinois River Sand Area Natural Division (Schwegman 1973). Initial land purchases for the state forest began in 1939 for the purpose of stabilizing soil of abandoned farmlands,

developing a wood product industry, and setting land aside for public recreation. From the 1940s into the 1950's, pine plantations were established mostly on old pastureland and abandoned cultivated fields, but also in dry sand prairies that were scattered throughout the forest. Presently 1,012 ha of marketable pine plantations are present in the state forest while most of the remainder is oak-hickory dry sand forest and savanna (Andrews 2004).

A few small prairie openings containing various quality dry sand prairie remnants are scattered throughout the forest. These dry sand prairie communities are mostly less than 5 ha in size. The two prairies studied are:

Burns Sand Prairie (S1/2 NW1/4 SW1/4 S4 T22N R7W), about 4 ha in size, is located on a broad dune ridge and is surrounded by black oak dominated forest on three sides. To the east is an abandoned cultivated field with many prairie species. Small oaks, mostly less than 2 m tall, are scattered throughout the prairie, their concentration increasing near the forest edge.

Quiver Sand Prairie (E1/2 NW1/4 SE1/4 S28 T23N R7W), about 2.4 ha in size, is located in a wide, shallow depression on the sides of surrounding dunes that are covered with oak forest and closed savanna. A few small oaks, usually less than 1 m tall, occur throughout the prairie. Numerous small oaks are present at the forest/prairie boundary.

Sand Ridge State Forest has a continental climate with warm summers and cold winters. Based on weather data from Havana mean annual precipitation is 96.0 cm, with May having the highest rainfall (11.3 cm). Mean annual temperature is 10.8°C with the hottest month being July (average of 24.6°C), and the coldest January (average of -5.0°C). Frost-free days range from 140 to 206, with the average being 173 days per year (Midwestern Regional Climate Center 2004). The soils are mostly excessively drained Plainfield sands and Bloomfield sands (Calsyn 1995) that form the dune and swale topography known as the Parkland Formation (Willman and Frye 1970).

METHODS

Sand Ridge State Forest was visited more than 15 times in 2003 and 2004 to study the floristic composition of sand prairie and sand forest communities. Voucher specimens were collected, identified, and deposited in the herbarium of the Illinois Natural History Survey, Champaign, Illinois (ILLS). Determination of non-native species followed Mohlenbrock (2002) and Gleason and Cronquist (1991). Nomenclature follows Mohlenbrock (2002) while community classification follows White and Madany (1978). All species are listed in Appendix I along with the site, collector, and collecting number.

In late summer of 2004 four 25 m transects were located randomly along cardinal compass directions in Burns and Quiver prairies. Along each transect, 1 m^2 quadrates were spaced at 1 m intervals (n=25/transect), odd-numbered quadrates to the right, even-numbered quadrates to the left. A random numbers table was used to determine the number of meters (0 to 9) the quadrate was located from the transect line. Species cover was determined using the Daubenmire cover class system (Daubenmire 1959) as modified by Bailey and Poulton (1968). Importance value (IV) for ground layer species was determined by summing relative cover and relative frequency.

RESULTS

In the two sand prairies a total of 124 vascular plant species within 101 genera and 45 families were documented. Of these, none were fern and fern-allies, four were a gymnosperms, 83 dicots in 72 genera and 39 families, and 37 monocots in

27 genera and four families. One threatened species, *Cyperus grayioides* (sand prairie flatsedge) was encountered (Herkert and Ebinger 2002). The predominant plant families were the Poaceae with 24 species and the Asteraceae with 14 species (Appendix I).

Schizachyrium scoparium (little bluestem) had the highest importance value (IV) in both prairies. This species was present in nearly every plot on both prairies and had an IV of 35.7 on Burns Prairie and 40.1 on Quiver Prairie (Table 1 and 2). *Tephrosia virginiana* (goat's-rue), *Opuntia humifusa* (common prickly pear), and *Ambrosia psilostachya* (western ragweed) were among the top five species on both prairies. Other common grasses were *Dichanthelium villosissimum* (hairy panic grass) on both prairies and *D. depauperatum* (panic grass) on Quiver Prairie. Overall, the five native prairie species that are typical components of dry sand prairies had IV's greater than 10 (Table 1 and 2). All would be expected in high quality dry sand prairie communities in Illinois.

While two exotic species were encountered in the plots, only 11 were collected within the prairies (Appendix I). None were encountered in the plots on Quiver Prairie (Table 2), while *Mollugo verticillata* (carpetweed) were present in low numbers on Burns Prairie (Table 1). The remaining exotics were predominantly at the edges of the prairies, generally in areas of disturbance. The naturalized *Rumex acetosella* (sour dock), a pervasive species of many Illinois sand prairies, was not encountered in the plots or observed in either prairie.

DISCUSSION

Burns and Quiver dry sand prairies are very similar to the mature dry sand prairies at Henry Allen Gleason Nature Preserve (McClain et al. 2005), Long Branch Nature Preserve (Phillippe et al. 2005), and Sand Prairie-Scrub Oak Nature Preserve (McClain et al. 2005), all in Mason County, Illinois. Four of the top five dominants were identical in all preserves with little bluestem dominant and western ragweed, common prickly pear, and goat's-rue important subdominants. Of these species, goat's-rue was not found in the plots at Long Branch Nature Preserve. This species is relatively common on that prairie, but has a clumped distribution and was absent in the general area where the line transects were randomly placed (Phillippe et al. 2005).

Gleason (1910) referred to dry sand prairie communities as the bunch-grass association and listed many of species and dominants recorded during the present study. In all dry sand prairies little bluestem generally formed dense, various-sized clumps, usually circular in outline. These clumps were generally between 15 and 35 cm wide, some being dead in the center, an indication of their age. Open sand, common between the clumps, was occupied by other species. Bare ground and litter averaged 15.06 for Quiver Prairie and 27.31 for Burns Prairie (Table 1 and 2).

The lack of exotic species, high species diversity, and number of conservative prairie species, indicate that the mature dry sand prairie openings at Sand Ridge State Forest are of high natural quality. Many prairie openings were destroyed when pines were planted in them in the 1940s and early 1950s. Also, many small remnants have been lost due to woody encroachment and fire suppression. The few remaining sand prairie openings should be managed by periodic fires and by the removal of encroaching trees, particularly at the prairie/forest boundaries.

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Table 1. Frequency (%), average cover, relative frequency, relative cover, and importance value of the ground layer species encountered at Quiver sand prairie, Sand Ridge State Forest, Mason County, Illinois. (* non-native species)

Species	Freq. %	Average Cover	Rel. Freq.	Rel. Cover	I. V.
Schizachyrium scoparium	100	25.90	10.6	29.5	40.1
Ambrosia psilostachya	98	19.62	10.4	22.3	32.7
Opuntia humifusa	100	9.46	10.6	10.8	21.4
Tephrosia virginiana	43	11.80	4.6	13.4	18.0
Dichanthelium depauperatum	63	6.18	6.7	7.0	13.7
Dichanthelium villosissimum	56	2.12	5.9	2.4	8.3
Cyperus lupulinus	68	0.42	7.2	0.5	7.7
Sporobolus clandestinus	36	1.50	3.8	1.7	5.5
Monarda punctata	36	1.40	3.8	1.6	5.4
Oenothera clelandii	41	0.63	4.3	0.7	5.0
Rhus aromatica	7	2.56	0.7	2.9	3.6
Carex muhlenbergii	22	0.83	2.3	1.0	3.3
Crotonopsis linearis	29	0.15	3.1	0.2	3.3
Conyza canadensis	26	0,21	2.8	0.2	3.0
Dichanthelium oligosanthes	22	0.46	2.3	0.5	2.8
Physalis heterophylla	15	0.74	1.6	0.9	2.5
Fallopia cristata	19	0.25	2.0	0.3	2.3
Solidago nemoralis	20	0.15	2.1	0.2	2.3
Pseudognaphalium obtusifolium	14	0.63	1.5	0.7	2.2
Bouteloua hirsuta	13	0.44	1.4	0.5	1.9
Chamaecrista fasciculata	11	0.35	1.2	0.4	1.6
Brickellia eupatorioides	9	0.44	1.0	0.5	1.5
Eragrostis spectabilis	10	0.37	1.1	0.4	1.5
Lespedeza capitata	11	0.13	1.2	0.2	1.4
Polygonum tenue	10	0.05	1.1	0.1	1.2
Carex tonsa	6	0.28	0.6	0.3	0.9
Euphorbia corollata	8	0.09	0.8	0.1	0.9
Asclepias verticillata	7	0.04	0.7	--	0.7
Commelina erecta	5	0.05	0.5	0.1	0.6
Cyperus schweinitzii	6	0.03	0.6	--	0.6
Leptoloma cognatum	5	0.08	0.5	0.1	0.6
Fragaria virginiana	3	0.21	0.3	0.2	0.5
Bouteloua curtipendula	3	0.07	0.3	0.1	0.4
Chrysopsis camporum	2	0.06	0.2	0.1	0.3
Eragrostis trichodes	3	0.19	0.3	--	0.3
Strophostyles helvula	2	0.06	0.2	0.1	0.3
Carex meadii	2	0.01	0.2	--	0.2
Chenopodium standleyanum	2	0.01	0.2	--	0.2
Froelichia floridana	2	0.01	0.2	--	0.2
Penstemon pallidus	2	0.01	0.2	--	0.2
Sorghastrum nutans	2	0.04	0.2	--	0.2
Croton glandulosus	1	0.01	0.1	--	0.1
Lactuca canadensis	1	0.03	0.1	--	0.1
Rhus glabra	1	0.03	0.1	--	0.1
Talinum rugospermum	1	0.01	0.1	--	0.1
Tridens flavus	1	0.01	0.1	--	0.1
Triplasis purpurea	1	0.01	0.1	--	0.1
Viola pedata	1	0.01	0.1	--	0.1

Totals	88.14	100.0	100.0	200.0
Average bare ground and litter	15.06			

Table 2. Frequency (%), average cover, relative frequency, relative cover, and importance value of the ground layer species encountered at Burns sand prairie, Sand Ridge State Forest, Mason County, Illinois. (* non-native species)

Species	Freq. %	Average Cover	Rel. Freq.	Rel. Cover	I. V.
Schizachyrium scoparium	99	18.26	9.2	26.5	35.7
Tephrosia virginiana	60	13.49	5.6	19.6	25.2
Dichanthelium villosissimum	96	9.44	8.9	13.7	22.6
Ambrosia psilostachya	96	8.21	8.9	11.9	20.8
Opuntia humifusa	84	6.51	7.8	9.4	17.2
Crotonopsis linearis	94	0.50	8.7	0.7	9.4
Pseudognaphalium obtusifolium	45	2.56	4.2	3.7	7.9
Cyperus lupulinus	73	0.37	6.8	0.5	7.3
Leptoloma cognatum	33	2.76	3.0	4.0	7.0
Carex muhlenbergii	64	0.55	6.0	0.8	6.8
Commelina erecta	58	0.34	5.4	0.5	5.9
Carex tonsa	43	0.74	4.0	1.1	5.1
Conyza canadensis	50	0.33	4.6	0.5	5.1
Croton glandulosus	34	0.20	3.2	0.3	3.5
Rhus aromatica	10	1.77	0.9	2.6	3.5
Oenothera clelandii	21	0.13	2.0	0.2	2.2
Eragrostis spectabilis	14	0.49	1.3	0.7	2.0
Lespedeza capitata	10	0.54	0.9	0.8	1.7
Dichanthelium depauperatum	7	0.52	0.6	0.8	1.4
Aristida tuberculosa	12	0.11	1.1	0.2	1.3
Cyperus schweinitzii	10	0.05	0.9	0.1	1.0
Eragrostis trichodes	7	0.23	0.6	0.3	0.9
Dichanthelium oligosanthes	5	0.10	0.5	0.2	0.7
Froelichia floridana	9	0.07	0.8	0.1	0.9
Liatris aspera	3	0.19	0.3	0.3	0.6
Quercus velutina	3	0.21	0.3	0.3	0.6
Polygonum tenue	5	0.03	0.5	--	0.5
Apocynum sibiricum	3	0.07	0.3	0.1	0.4
Bulbostylis capillaris	4	0.02	0.4	--	0.4
Talinum rugospermum	4	0.02	0.4	--	0.4
Fallopia cristata	3	0.02	0.3	--	0.3
Lactuca canadensis	3	0.04	0.3	--	0.3
**Mollugo verticillata*	3	0.02	0.3	--	0.3
Paspalum bushii	2	0.06	0.2	0.1	0.3
Plantago patagonica	3	0.02	0.3	--	0.3
Cyperus grayoides	2	0.01	0.2	--	0.2
Diodia teres	1	--	0.1	--	0.1
Physalis virginiana	1	0.03	0.1	--	0.1
Solidago nemoralis	1	0.03	0.1	--	0.1
Chenopodim standleyanum	1	0.05	--	--	--
Euphorbia corollata	1	0.05	--	--	--
Totals		69.14	100.0	100.0	200.0
Average bare ground and litter		27.31			

APPENDIX I. Vascular species encountered at two dry sand prairies at Sand Ridge State Forest, Mason County, Illinois, listed alphabetically by family under the major plant groups. An asterisk indicates non-native (exotic) species (*). Following the scientific name and in parenthesis is the name of the prairie where the taxon was found, (BP) for Burns dry sand prairie and (QP) for Quiver dry sand prairie. Following the name of the prairie, collecting numbers preceded by the initial of the collector's name are given (B) Daniel T. Busemeyer, (F) Mary Ann Feist, (G) Sophia Gehlhausen, (M) Paul B. Marcum, and (P) Loy R. Phillippe.

Sand Ridge State Forest Burns Prairie Species List

SPERMATOPHYTES: GYMNOSPERMS

CUPRESSACEAE

Juniperus virginiana L.: (BP) P 36479

PINACEAE

**Pinus resinosa* Ait.: (BP) P 37183
**Pinus strobus* L.: (BP) P 37175
**Pinus sylvestris* L.: (BP) P 36481

SPERMATOPHYTES: ANGIOSPERMS

MONOCOTS

COMMELINACEAE

Commelina erecta L. var. *erecta*: (BP) P 36950, (QP) F 2781, M 2846
Tradescantia ohiensis Raf.: (BP) P 36780, (QP) P 36752

CYPERACEAE

Bulbostylis capillaris (L.) C.B. Clarke: (BP) P 36952
Carex meadii Dewey: (BP) P 36782, (QP) P 36737
Carex muhlenbergii Schk.: (BP) P 36757, (QP) P 36736
Carex tonsa (Fern.) Bickn.: (BP) P 36478, (QP) F 2522
Cyperus grayioides Mohlenbr.: (BP) M 2684, P 36748
Cyperus lupulinus (Spreng.) Marcks var. *macilentus* (Fern.) Marcks: (BP) P 36949, (QP) F 2784
Cyperus schweinitzii Torr.: (BP) P 36945, (QP) F 2794
Eleocharis erythropoda Steud.: (BP) P 36955
Eleocharis ovata (Roth) Roem. & Schultes: (BP) P 36953

JUNCACEAE

Juncus acuminatus Michx.: (BP) P 36951
Juncus interior Wieg.: (BP) P 36763

POACEAE

Agrostis hyemalis (Walt.) BSP.: (BP) P 36759, (QP) F 2785
Andropogon gerardii Vitman: (BP) P 37173
Aristida tuberculosa Nutt.: (BP) P 37169, (QP) M 2848, M 2850
Bouteloua curtipendula (Michx.) Torr.: (QP) M 2826
Bouteloua hirsuta Lag.: (QP) M 2660
**Bromus tectorum* L.: (BP) P 36775
Calamovilfa longifolia (Hook.) Scribn.: (BP) M 2685
Dichanthelium depauperatum (Muhl.) Gould: (BP) P 36760, (QP) M 2844, P 36735
Dichanthelium oligosanthes (Schult.) Gould: (BP) P 36772, (QP) P 36738
Dichanthelium villosissimum (Nash) Freckm.: (BP) P 36756, (QP) P 36739
**Echinochloa crus-galli* (L.) P. Beauv.: (BP) P 36954
Eragrostis spectabilis (Pursh) Steud.: (BP) P 37170, (QP) M 2839
Eragrostis trichodes (Nutt.) Wood: (BP) Site Record, (QP) M 2845
Heterostipa spartea (Trin.) Barkworth: (BP) P 36781, (QP) F 2805
Hordeum pusillum Nutt.: (BP) P 36774
Leptoloma cognatum (Schult.) Chase: (BP) M 2683, (QP) M 2836
Paspalum bushii Nash: (BP) M 2682
**Poa pratensis* L.: (QP) F 2799
Schizachyrium scoparium (Michx.) Nash: (BP) Site Record, (QP) M 2829

Sorghastrum nutans (L.) Nash: (BP) P 37180, (QP) M 2834
Sporobolus clandestinus (Biehler) Hitchc.: (QP) M 2838
Tridens flavus (L.) Hitchc.: (QP) Site Record
Triplasis purpurea (Walt.) Chapm.: (QP) M 2847, M 2849
Vulpia octoflora (Walt.) Rydb. var. *tenella* (Willd.) Fern.: (BP) P 36773, (QP) P 36751

DICOTS

ACANTHACEAE

Ruellia humilis Nutt.: (QP) F 2791

AMARANTHACEAE

Froelichia floridana (Nutt.) Moq.: (BP) M 2679, (QP) Site Record

ANACARDIACEAE

Rhus aromatica Ait.: (BP) B 1675, P 36767, (QP) F 2801
Rhus glabra L.: (QP) F 2803
Rhus hirta L.: (QP) F 2802

APOCYNACEAE

Apocynum sibiricum Jacq.: (BP) Site Record

ASCLEPIADACEAE

Asclepias amplexicaulis Small: (BP) P 36766, (QP) F 2796
Asclepias hirtella (Pennell) Woodson: (BP) P 36956
Asclepias tuberosa L.: (QP) F 2790
Asclepias verticillata L.: (QP) M 2664

ASTERACEAE

**Achillea millefolium* L.: (QP) F 2783
Ambrosia psilostachya DC.: (BP) P 37172, (QP) M 2840
Brickellia eupatorioides (L.) Shinners: (QP) M 2835
Chrysopsis camporum Greene: (BP) P 36795, P 37254, (QP) F 2780, M 2828
Conyza canadensis (L.) Cronq.: (BP) P 37178, (QP) M 2832
Erigeron strigosus Muhl.: (BP) P 36784, (QP) F 2778
Helianthus occidentalis Riddell: (QP) M 2852
Krigia virginica (L.) Willd.: (BP) B 1673, (QP) P 36741
Lactuca canadensis L.: (BP) P 37184, (QP) M 2842
Liatris aspera Michx. (BP) Site Record
Pseudognaphalium obtusifolium (L.) Hilliard & Burtt.: (BP) P 37176, (QP) M 2837
Rudbeckia hirta L.: (QP) F 2787
Senecio plattensis Nutt.: (BP) P 36776, (QP) P 36749
Solidago nemoralis Ait.: (BP) P 37174, (QP) M 2833

BORAGINACEAE

Lithospermum croceum Fern.; (BP) P 36768, (QP) P 36740

BRASSICACEAE

**Alliaria petiolata* (Bieb.) Cavara & Grande: (B) B 1676
Arabis canadensis L.: (QP) P 36747
Draba reptans (Lam.) Fern.: (QP) F 2524
**Lepidium densiflorum* Schrad.: (BP) P 36770, (QP) P 36746
Lepidium virginicum L.: (BP) P 36769, (QP) F 2792

CACTACEAE

Opuntia humifusa (Raf.) Raf.: (BP) P 36755, (QP) F 2788

CAESALPINIACEAE

Chamaecrista fasciculata (Michx.) Greene: (BP) P 37253, (QP) M 2663

CAMPANULACEAE

Triodanis perfoliata (L.) Nieuwl.: (BP) P 36758, P 36946, (QP) F 2793

CHENOPODIACEAE

Chenopodium standleyanum Aellen: (QP) M 2665
Cycloloma atriplicifolium (Spreng.) Coult.: (BP) P 36958

CISTACEAE

Helianthemum canadense (L.) Michx.: (BP) P 36785, (QP) P 36750

CORNACEAE

Cornus drummondii C.A. Mey.: (BP) P 36790

EUPHORBIACEAE

Croton glandulosus L.: (BP) M 2680, (QP) F 2800
Crotonopsis linearis Michx.: (BP) M 2677, (QP) M 2662, M 2831
Euphorbia corollata L.: (BP) Site Record, (QP) F 2786

FABACEAE

Amorpha canescens Pursh: (QP) F 2789
Desmodium sessilifolium (Torr.) Torr. & Gray: (QP) M 2851
Lespedeza capitata Michx.: (BP) P 37179, (QP) M 2830
Strophostyles leiosperma (Torr. & Gray) Piper: (QP) M 2843
Tephrosia virginiana (L.) Pers.: (BP) P 36947, (QP) M 2841

FAGACEAE

Quercus marilandica Muench.: (QP) M 2667
Quercus velutina Lam.: (BP) P 37171

FUMARIACEAE

Corydalis micrantha (Englem.) Gray var. *micrantha*: (BP) P 36793

GERANIACEAE

Geranium carolinianum L.: (BP) P 36792

GROSSULARIACEAE

Ribes missouriense Nutt.: (BP) P 36482

LAMIACEAE

Monarda punctata L.: (QP) 2797
Teucrium canadense L.: (BP) P 37177, (QP) F 2798

MALVACEAE

Callirhoe triangulata (Leavenw.) Gray: (BP) M 2686, (QP) M 2661

MOLLUGINACEAE

**Mollugo verticillata* L.: (BP) P 36765

MORACEAE

**Morus tatarica* L.: (BP) P 36789

ONAGRACEAE

Oenothera clelandii W. Dietr., Raven, & W.L. Wagner: (BP) P 36957, (QP) F 2779

OXALIDACEAE

Oxalis violacea L.: (QP) P 36754

PLANTAGINACEAE

Plantago patagonica Jacq.: (BP) P 36761

POLEMONIACEAE

Phlox bifida Beck: (BP) P 36484, (QP) F 2525

POLYGONACEAE

Fallopia cristata (Engelm. & Gray) Holub.: (BP) P 37252, (QP) M 2666
Polygonum tenue Michx.: (BP) P 37251, (QP) M 2827

PORTULACACEAE

Talinum rugospermum Holz.: (BP) P 36764, (QP) G 36

PRIMULACEAE

Androsace occidentalis Pursh: (BP) P 36483, (QP) F 2523

ROSACEAE

Fragaria virginiana Duchesne: (BP) P 36777, (QP) P 36743
Geum canadense Jacq.: (BP) P 36778
Prunus serotina Ehrh.: (BP) P 36783, (QP) F 2804
Rosa carolina L. var. *carolina*: (BP) P 36786
Rubus allegheniensis Porter: (BP) P 36788
Rubus occidentalis L.: (BP) P 36779

RUBIACEAE

Diodia teres Walt. (BP) M 2681
Galium aparine L.: (BP) P 36771, (QP) P 36733

RUTACEAE

Ptelea trifoliata L.: (QP) P 36744

SCROPHULARIACEAE

Lindernia anagallidea (Michx.) Pennell: (BP) M 2678
Nuttallanthus canadensis (L.) D. Sutton: (BP) B 1674, (QP) P 36734
Penstemon pallidus Small: (QP) P 36748

SOLANACEAE

Physalis heterophylla Nees: (BP) P 37181, (QP) F 2795, M 2668
Physalis virginiana Mill.: (BP) P 36762
Solanum carolinense L.: (BP) P 36791
Solanum ptychanthum Dunal: (BP) P 36787

URTICACEAE

Parietaria pensylvanica Muhl.: (QP) P 36745

VIOLACEAE

Viola pedata L.: (QP) P 36753
*Viola rafinesquei Greene: (BP) P 36480, (QP) P 36742

ZYGOPHYLLACEAE

*Tribulus terrestris L.: (BP) P 36794

A Floristic Study of Sand Prairie-Scrub Oak Nature Preserve, Mason County, Illinois

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ABSTRACT

The 590 ha Sand Prairie-Scrub Oak Nature Preserve in Mason County, Illinois contains remnant sand prairies, sand savanna, sand forest, and successional fields. Purchased in 1969, these abandoned agricultural fields have been allowed to re-vegetate naturally. During the present study the vegetation of the mature dry sand prairie was compared with two successional fields, one 60- and one 30-years-old. The mature dry sand prairie remnants are dominated by *Schizachyrium scoparium* (Michx.) Nash, *Dichanthelium villosissimum* (Nash) Freckm., *Tephrosia virginiana* (L.) Pers, *Ambrosia psilostachya* DC., and *Opuntia humifusa* (Raf.) Raf. Though these five species are usually present, *Eragrostis trichodes* (Nutt.) Wood dominated the 60-year-old successional fields. The 30-year-old successional field was dominated by *Eragrostis trichodes, Strophostyles helvula* (L.) Ell., and *Monarda punctata* L. A total of 393 vascular plant species were documented for the preserve.

INTRODUCTION

Sand prairie communities are present in Illinois on windblown sands deposits located along the Illinois, Kankakee, Green, and Mississippi Rivers, and the shores of Lake Michigan (Gleason 1910, Vestal 1913). Due to their arid nature, they were the last of the extensive Illinois prairie to be converted to agriculture. In the early 1900's, thousands of acres of sand prairie still remained (Hart and Gleason 1907, Gleason 1910, Sampson 1921). With the advent of central pivot irrigation, much of the remaining sand prairie was converted to agriculture between 1940 and 1960. The majority of the natural areas that remained were unsuitable for cultivation due to extensive sand dunes, large areas of actively moving sand known as blowouts, or depressions difficult to drain.

The most extensive sand deposit in Illinois are those associated with the Illinois River in the central part of the state. Within these deposits the Illinois Nature Preserves Commission has preserved many of the best remaining examples of the sand communities that were once the dominant vegetation of the region. To help accomplish this goal the Illinois Department of Natural Resources purchased the Sand Prairie-Scrub Oak Nature Preserve (SP-SONP). When purchased, much of the preserve consisted of sand forest, open woodlands, and savanna though some high quality sand prairie was also present along with numerous abandoned agricultural fields.

Since being purchased in 1969 the SP-SONP has been used for prairie vegetation studies. The mycorrhizal dependence of two sand prairie grasses was examined (Anderson and Liberta 1987, Dhillion et al. 1988,

Benjamin et al. 1989, Anderson et al. 1994). Also, the effects of fire on savanna and adjacent forest vegetation were studied (Anderson and Brown 1986, Dhillion and Anderson 1994), while recently the composition and structure of the sand forest communities was examined (McClain et al. 2002). Except for the early works by Hart and Gleason (1907) and Gleason (1910), however, little information has been published on the composition of the sand prairie communities. High quality dry sand prairie remnants occur on the SP-SONP as well as various aged abandoned fields. The purpose of this study was to compare the plant species composition, vegetation structure, and floristic quality of a dry sand prairie remnant with various aged old-field communities, and to document the vascular flora of the SP-SONP.

DESCRIPTION OF THE STUDY AREA

The SP-SONP is a 590 ha site located between the villages of Bath and Kilbourne (T20N, R9W, S13, 14, 23, 26,) Mason County, in the Illinois River Section of the Illinois River and the Mississippi River Sand Areas Natural Division (Schwegman 1973). This sand deposit was created about 14,500 years ago when glacial moraines were breached, resulting in the Kankakee Torrent (Willman 1973, King 1981). These floodwaters carried huge amounts of sand and gravel that were deposited when the waters of the Kankakee Torrent slowed upon entering the broad lowlands of the Illinois River below present day Hennepin, Illinois. These sand deposits were subsequently shaped by winds, creating the dune and swale topography known as the Parkland Formation (Willman and Frye 1970). The soils of the SP-SONP are excessively drained Plainfield sands (Calsyn 1995). These soils consist of about 95% sand, 4% silt, and 1% clay. Soil pH ranges from 5.1 to 5.3 and is low in organic matter and nitrogen (Benjamin et al. 1989).

Within the SP-SONP many sand communities exist. Presently the most common are sand forests that were probably open woodlands and savannas during early settelment time (Rodgers and Anderson 1979). At the time of purchase a few remnant sand prairies were present based on a United States Department of Agriculture aerial photograph dated 9 July 1939. These remnants were probably grazed, but there is no indication that they were ever cultivated. One area, originally considered to be a prairie remnant, was determined to be in row crop agriculture according to the 1939 photograph. Subsequent aerial photographs indicate that farming of this site was abandoned in the early 1940's (60-year-old successional field). Other fields were taken out of agriculture at the time of purchase in 1969 (30-year-old successional fields).

The only management activities conducted on the SP-SONP have been prescribed burning to keep the forests open, and invasive exotic species control to eliminate *Robinia pseudoacacia* (black locust) from the prairies and old fields. The north side of the preserve, the location of the study sites, was prescribed burned in 1994. Prior to this date, prescribed fire was used in smaller areas in the interior of the preserve in 1984, 1987, 1990, and 1992 mostly in the sand forest vegetation.

Climate at the SP-SONP is continental with warm summers and cold winters. Based on weather data from Havana, Illinois about 12 km north of the SP-SONP, mean annual precipitation is 96.0 cm, with May having the highest rainfall (11.3 cm). Mean annual temperature is 10.8°C with the hottest month being July (average of 24.6°C), and the coldest

January (average of -5.0°C). Frost free days range from 140 to 206, with the average being 173 day per year (Midwestern Regional Climate Center 2002).

METHODS

The SP-SONP was visited throughout the growing season of 1976 by one of the authors (Schwegman 1977)). The preserve has been visited many times since this initial study, with a concentrated effort during the 2000 to 2003 growing season. During these trips specimens were collected and deposited in the herbarium of the Illinois Natural History Survey, Champaign, Illinois (ILLS), and the Stover-Ebinger Herbarium, Eastern Illinois University, Charleston, Illinois (EIU). Gleason and Cronquist (1991) and Mohlenbrock (1986) were used to designating non-native species. Nomenclature follows Mohlenbrock (1986).

In late summer of 2000 two 25 m transects were located randomly along cardinal compass directions in a mature dry sand prairie remnant, a 60-year-old, and a 30-year-old successional field. Along each transect, 1 m^2 quadrates were located at 1 m intervals (n=25/transect). Odd-numbered quadrats were located on the right side; even-numbered to the left. A random numbers table was used to determine the number of meters (0 to 9) the quadrate was located from the transect line. Species cover was determined using the Daubenmire cover class system (Daubenmire 1959) as modified by Bailey and Poulton (1968). Importance value (IV) was determined by summing relative cover and relative frequency.

RESULTS

A total of 387 species within 235 genera and 76 families were documented on the preserve (Appendix I). Fern and fern-allies were represented by only one species, while gymnosperms accounted for two. Of the remainder, 108 were monocots in 11 families and 61 genera and 282 were dicots in 64 families and 182 genera. Non-native (exotic) species accounted for 71 taxa, about 19% of the species collected. The predominant plant families were the Asteraceae with 65 species and the Poaceae with 59. The state endangered *Echinodorus tenellus* and Schoenoplectus hallii were encountered at the edge of a sand pond, while the state threatened *Cyperus grayoides* was common in disturbed sand prairies and blowouts (Herkert and Ebinger 2002).

Some of the species associated with wet areas reported by Schwegman (1977) were found around a sand pond located in a large blowout near the middle of the SP-SONP. This was a sizeable pond prior to the lowering of the water table by drainage of the land surrounding the preserve. Presently water rarely accumulates in this blowout and these species many no longer occur on the preserve. It is possibly that they persist within the soil seed bank, however, and will appear in extremely wet years (McClain et al. 1997).

Mature Dry Sand Prairie: Of the species encountered *Schizachyrium scoparium* (little bluestem) was most important, having an average cover of 46.35, and an IV of 79.4 (Table 1). Also common, *Dichanthelium villosissimum* (hairy panic grass) was second with an IV of 30.6, *Tephrosia virginiana* (goat's-rue) was third with an IV of 28.3, *followed by Ambrosia psilostachya (western ragweed), and* Opuntia *humifusa* (common prickly pear). These five native prairie species, that are typical components of dry sand prairies in the Mason County sand deposits, had IV's greater than 10. All would be expected in high

quality dry sand prairie communities in Illinois. Of the 16 species encountered in the plots, 14 were perennials (Table 1).

60-year-old Successional Field: Last cultivated about 60 years ago this old-field contains many sand prairie species. *Eragrostis trichodes* (sand love grass), that was absent from the mature dry sand prairie was dominant with an average cover of 25.00, and an IV of 51.2. After 60 years this area contained many taxa commonly associated with mature sand prairies. Four of the top five species in IV (little bluestem, western ragweed, hairy panic grass, and common prickly pear) were among the top five encountered in the mature dry sand prairie (Table 1). Other important differences were the relatively low IV for little bluestem, and the absence of goat's-rue. Of the 20 herbaceous species encountered in the plots, 17 were perennials (Table 1).

30-year-old Successional Field: This field, taken out of cultivation when the preserve was purchased, contained many species not found in the mature sand prairie. Sand love grass was the dominant with an average cover of 61.70 and an IV of 97.4, while the herbaceous vine *Strophostyles helvula* (wild bean) was second with an IV of 43.7, and *Monarda puntata* (horsemint) was third with an IV of 16.9 (Table 1). Of the dominants associated with mature dry sand prairies, little blue stem, western ragweed, and goat's-rue were not encountered while hairy panic grass and common prickly pears were rare. Of the 22 species encountered in the plots, 18 were perennials (Table 1).

DISCUSSION

In the Illinois River sand deposits native sand prairie species rapidly colonize agricultural fields, especially in areas with a readily available native seed source. Most of these early successional species, however, are those associated with natural sand area disturbances such as blowouts or are native adventive species. After 30 years, however, few of the species associated with mature dry sand communities were found in the plots. Colonization by characteristic herbaceous species such as little bluestem, hairy panic grass, goat's-rue, and western ragweed require much longer, particularly when sites re-vegetate naturally. This slow colonization is not due to the lack of a seed source as native prairie is adjacent to the fields. This slow rate of colonization is not completely understood. It may be related to disruption of the mycorrhizal community in the soil, lack of certain soil nutrients, or competition from aggressive successional species such as sand love grass (Anderson and Liberta 1987, Dhillion et al. 1988, Anderson et al. 1994).

Though 71 non-native species were encountered at the SP-SONP, most were restricted to roadsides, fence rows, or in the remnants of pine plantations and abandoned home sites. Also, some were encountered around the "blowouts", others associated with past off-road vehicle disturbances. Most of the non-native species are not management problems. The major exceptions are black locust that is highly invasive in remnant prairies and old fields, and *Lonicera maackii* (Amur honeysuckle) and *Alliaria petiolata* (garlic mustard) which are serious invaders of the sand forests. The only exotic found in the study plots was *Mollugo verticillata* (carpetweed) which had an IV of 0.5 in the 30-year-old successional field.

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Table 1. Importance values (I.V.) and average cover of the ground layer species encountered in a mature sand prairie, and a 60, and a 30 year successional field at the Sand Prairie Scrub Oak Nature Preserve, Mason County, Illinois. Species with I.V's of 1.0 or less and found in only one of the areas are included as others.

	Mature Prairie		60 Year Field		30 Year Field	
Species	I.V.	Average Cover	I.V.	Average Cover	I.V.	Average Cover
Schizachyrium scoparium	79.4	46.35	31.7	14.83	--	--
Dichanthelium villosissimum	30.6	9.22	21.2	7.20	1.2	0.07
Tephrosia virginiana	28.3	10.51	--	--	--	--
Ambrosia psilostachya	22.2	6.74	23.2	7.23	--	--
Opuntia humifusa	15.2	3.12	18.1	6.22	0.6	0.06
Eragrostis spectabilis	6.0	0.91	9.5	2.70	10.6	2.29
Cyperus schweinitzii	5.6	0.33	4.6	0.23	--	--
Calamovilfa longifolia	3.7	0.09	--	--	--	--
Crotonopsis linearis	2.1	0.05	--	--	--	--
Oenothera rhombipetala	1.8	0.19	4.0	0.31	1.1	0.02
Cyperus grayoides	1.7	0.09	0.3	0.01	--	--
Carex muhlenbergii	1.0	0.12	2.3	0.90	--	--
Pseudognaphalium obtusifolium	0.5	0.06	3.5	1.08	0.6	0.06
Others (3 species)	1.9	0.19	--	--	--	--
Eragrostis trichodes	--	--	51.2	25.00	97.4	61.70
Froelichia floridana	--	--	11.1	2.24	--	--
Conyza canadensis	--	--	4.1	0.36	1.8	0.18
Paspalum bushii	--	--	3.9	0.91	9.8	1.00
Croton glandulosus	--	--	3.8	0.16	--	--
Chenopodium simplex	--	--	3.2	0.14	1.1	0.02
Physalis heterophylla	--	--	2.0	0.25	4.8	0.90
Monarda punctata	--	--	0.7	0.02	16.9	4.06
Others (2 species)	--	--	1.6	0.14	--	--
Strophostyles helvula	--	--	--	--	43.7	15.36
Tridens flavus	--	--	--	--	2.5	0.38
Asclepias syriaca	--	--	--	--	2.4	0.24
Ampelamus albidus	--	--	--	--	1.1	0.02
Others (7 species)	--	--	--	--	4.4	0.75
Totals	200.0	77.97	200.0	69.93	200.0	87.11

Asclepias amplexicaulis Small 29810
Asclepias syriaca L. 29934
Asclepias tuberosa L. 29809
Asclepias verticillata L. 29935

Asteraceae
**Achillea millefolium* L. 29811
Ageratina altissima (L.) R.M. King & H. Robins. 29937
Ambrosia artemisiifolia L. 25964
Ambrosia psilotachya DC. 30384
Ambrosia trifida L. 30385
Antennaria plantaginifolia (L.) Hook. 29936
Arnoglossum atripicifolium (L.) H. Robins. 30207
Artemisia campestris L. 30203
Aster cordifolius L. 31203
Aster dumosus L. (JES)
Aster ericoides L. 30483
Aster lanceolatus Willd. 30481
Aster lateriflorus (L.) Britt. 31202
Aster ontarionis Wieg. (JES)
Aster oolentangiensis Riddell 30484
Aster pilosus L. 30386
Aster racemosus L. 30482
Aster sagittifolius Willd. (JES)
Aster urophyllus Lindl. 25989
Bidens bipinnata L. 25950
Brickellia eupatorioides (L.) Shinners 30387
**Carduus nutans* L. 29812
Chrysopsis camporum Greene 29528
Cirsium discolor (Muhl.) Spreng. 30388
Conoclinium coelestinum (L.) DC. 30390
Conyza canadensis (L.) Cronq. 30202
Coreopsis lanceolata L. 29678
Coreopsis palmata Nutt. 30208
Erechtites hieracifolia (L.) Raf. 30389
Erigeron annuus (L.) Pers. 29814
Erigeron strigosus Muhl. 29813
Eupatoriadelphus purpureus (L.) R.M. King & H. Robins. 30485
Eupatorium altissimum L. 30478
Eupatorium serotinum Michx. 30391
Euthamia graminifolia (L.) Nutt. 30392
Euthamia gymnospermoides Greene P36125
Helianthus divaricatus L. 25990
Helianthus grosseserratus Martens. (JES)
Helianthus hirsutus Raf. 30394
Helianthus occidentalis Riddell 25987
Helianthus pauciflorus Nutt. 30206
**Helianthus petiolaris* Nutt. 30205
Heliopsis helianthoides (L.) Sweet 29938
Heterotheca subaxillaris (Lam.) Britt. & Rusby 31000
Hieracium scabrum Michx. 25992
Ionactis linariifolius (L.) Greene P36123
Krigia virginica (L.) Willd. 29524
Lactuca canadensis L. 26006
Lactuca floridana (L.) Gaertn. (JES)
**Lactuca serriola* L. 29939
Liatris aspera Michx. 30395
Pseudognaphalium obtusifolium (L.) Hilliard & Burtt. 30393
Pyrrhopappus carolinianus (Walt.) DC. P36119
Ratibida pinnata (Vent.) Barnh. 29940
Rudbeckia hirta L. 29815
Senecio plattensis Nutt. 29529
Solidago canadensis L. 30396
Solidago gigantea Ait. (JES)
Solidago missouriensis Nutt. 30995
Solidago nemoralis Ait. 30204
Solidago speciosa Nutt. (JES)
Solidago ulmifolia Muhl. *P36100*
Taraxacum officinale Weber 30201
**Tragopogon dubius* Scop. 29703
Xanthium strumarium L. 30480

Bignoniaceae
Campsis radicans (L.) Seem. 30209
**Catalpa speciosa* Warder 29941

Boraginaceae
**Buglossoides arvense* (L.) I.M. Johnston 29439
Hackelia virginiana (L.) I.M. Johnston 29942
Lithospermum canescens (Michx.) Lehm. (JES)
Lithospermum croceum Fern. 29527
Lithospermum incisum Lehm. 29526

Brassicaceae
**Alliaria petiolata* (Bieb.) Cavara & Grande 29523
Arabis canadensis L. 29687
Descurainia pinnata (Walt.) Britt. 29438
Draba reptans (Lam.) Fern. 29441
Erysinum capitatum (Dougl.) Greene 29531
**Lepidium densiflorum* Schrad. 29698

Rorippa sessiliflora (Nutt.) A. Hitchc. 30855

Cactaceae
Opuntia humifusa (Raf.) Raf. 30376

Caesalpiniaceae
Chamaechrista fasciculata (Michx.) Greene 30210
Chamaechrista nictitans (L.) Moench. 25275
Senna marilandica (L.) Link 30211

Campanulaceae
Lobelia spicata Lam. (JES)
Triodanis perfoliata (L.) Nieuwl. 29816

Cannabinaceae
**Cannabis sativa* L. 29817

Caprifoliaceae
**Lonicera maackii* (Rupr.) Maxim. 30212
Sambucus canadensis L. 30856

Caryophyllaceae
**Arenaria serpyllifolia* L. 29536
**Cerastium glomeratum* Thuill. 29535
**Dianthus armeria* L. 30999
**Holosteum umbellatum* L. 29444
Paronychia canadensis (L.) Wood 25276
Paronychia fastigiata (Raf.) Fern. 30397
**Saponaria officinalis* L. 29818
Silene antirrhina L. 29943
*Silene *pratensis* (Spreng.) Godron & Gren. 29671
Silene stellata (L.) Ait. f. 29944
**Stellaria media* (L.) Cyrillo 29537

Celastraceae
Celastrus scandens L. 31199

Chenopodiaceae
**Chenopodium album* L. 30398
Chenopodium desiccatum A. Nels. 25969
Chenopodium simplex (Torr.) Raf. 25945
Cycloloma atriplicifolium (Spreng.) Coult. 29946

Cistaceae
Helianthemum bicknellii Fern. 30998
Helianthemum canadense (L.) Michx. 29673
Lechea tenuifolia Michx. (JES)

Convolvulaceae
**Ipomoea hederacea* (L.) Jacq. 25953

Cornaceae
Cornus drummondii C.A. Mey. 29819
Cornus racemosa Lam. 30213

Cuscutaceae
Cuscuta gronovii Willd. 30399

Euphorbiaceae
Acalypha gracilens Gray 29947
Acalypha rhomboidea Raf. P36129
Chamaesyce geyeri (Engelm.) Small 25959
Chamaesyce maculata (L.) Small 30486
Croton glandulosus L. 25961
Crotonopsis linearis Michx. 25962
Euphorbia corollata L. 29948
Poinsettia dentata (Michx.) Kl. & Garcke 25960

Fabaceae
Amorpha canescens Pursh 29949
Amphicarpaea bracteata (L.) Fern. 30400
Astragalus distortus Torr. & Gray 29540
Baptisia bracteata Ell. P36116.2
Dalea candida (Michx.) Willd. (JES)
Desmodium glabellum (Michx.) DC. 30401
Desmodium illinoense Gray 30215
Desmodium sessilifolium (Torr.) Torr. & Gray 26005
**Kummerowia stipulacea* (Maxim.) Makino 29821
Lespedeza capitata Michx. 30402
**Medicago lupulina* L. 29823
**Melilotus alba* Medic. 29820
**Melilotus officinalis* (L.) Pallas 225971
**Robinia pseudoacacia* L. 29950
Strophostyles helvula (L.) Ell. 25966
Strophostyles leiosperma (Torr. & Gray) Piper 30214
Tephrosia virginiana (L.) Pers. 25278
**Trifolium campestre* Schreb. 29822
**Trifolium pratense* L. 29824
**Trifolium repens* L. 29825
**Vicia villosa* Roth. 29672

Fagaceae
Quercus x bushii Sarg. 29951
Quercus marilandica Muenchh. 29952
Quercus velutina Lam. 29953

Fumariaceae
Corydalis micrantha (Engelm.) Gray (JES)

Gentianaceae
Gentiana alba Muhl. (JES)

Geraniaceae
Geranium carolinianum L. 29681

Grossulariaceae
Ribes missouriense Nutt. 29685

Hypericaceae
Hypericum majus (Gray) Britt. (JES)
Hypericum mutilum L. (JES)
Hypericum sphaerocarpum Michx. P36091

Juglandaceae
Carya texana Buckl. 29954
Carya tomentosa (Poir.) Nutt. 29955
Juglans nigra L. 29956

Lamiaceae
Agastache nepetoides (L.) Ktze. 30216
**Lamium amplexicaule* L. 29446
**Leonurus cardiaca* L. 29826
Lycopus americanus Muhl. 30403
Monarda fistulosa L. 29827
Monarda punctata L. 30217
Physostegia virginiana (L.) Benth. P36122
Pycnanthemum pilosum Nutt. 25988
Scutellaria parvula Michx. P36077
Stachys palustris L. P36120
Teucrium canadense L. 25277

Lauraceae
Sassafras albidum (Nutt.) Nees 29828

Lythraceae
Rotala ramosior (L.) Koehne 30997

Malvaceae
Callirhoe triangulata (Leavenw.) Gray 29957

Molluginaceae
**Mollugo verticillata* L. 25972

Moraceae
**Maclura pomifera* (Raf.) Schneider 29958
**Morus alba* L. 29829

Nyctaginaceae
**Mirabilis nyctaginea* (Michx.) MacM. 29702

Onagraceae
Gaura biennis L. 30404
Ludwigia alternifolia L. 29959
Oenothera biennis L. 30405
Oenothera laciniata Hill 29680
Oenothera rhombipetala Nutt. 25967

Oxalidaceae
Oxalis stricta L. 29686
Oxalis violacea L. (JES)

Phytolaccaceae
Phytolacca americana L. 29960

Plantaginaceae
Plantago aristata Michx. (JES)
**Plantago lanceolata* L. 29831
Plantago patagonica Jacq. 29692
Plantago rugelii Dcne. 29832
Plantago virginica L. 29676

Polemoniaceae
Phlox bifida Beck 29440

Polygalaceae
Polygala polygama Walt. 25958
Polygala sanguinea L. P36096
Polygala verticillata L. (JES)

Polygonaceae
Antenoron virginianum (L.) Roberty & Vautier 30410
*Fallopia *convolvulus* (L.) A. Love 29961
Fallopia cristata (Engelm. & Gray) Holub. 25808
Fallopia scandens (L.) Holub. 30409
Persicaria coccinea (Muhl.) Greene 29962
Persicaria lapathifolia (L.) S.F. Gray 29963
Persicaria pensylvanica (L.) Small 30407
*Persicaria *vulgaris* Webb & Moq. 30408
*Polygonum *aviculare* L. 30406
Polygonum tenue Michx. 26003
**Rumex acetosella* L. 29675

Rumex crispus L. 29830

Portulacaceae
Claytonia virginica L. (JES)
Talinum rugospermum Holz. 29833

Primulaceae
Androsace occidentalis Pursh 29445
Lysimachia ciliata L. (JES)

Ranunculaceae
Anemone canadensis L. P36130
Anemone caroliniana Walt. 29442
Anemone cylindrica Gray (JES)
Anemone virginiana L. 29964
Ranunculus abortivus L. 29522

Rhamnaceae
Ceanothus americanus L. 25279

Rosaceae
Agrimonia gryposepala Wallr. P36131
Fragaria virginiana Duchesne 29534
Geum canadense Jacq. 25812
Malus ioensis (Wood) Britt. (JES)
Potentilla norvegica L. 30857
Potentilla recta L. 29834
Potentilla simplex Michx. 29697
Prunus angustifolia Marsh. 29516
Prunus serotina Ehrh. 29517
Rosa carolina L. 29835
Rosa multiflora Thunb. 29965
Rubus flagellaris Willd. 29684
Rubus occidentalis L. 29691
Rubus pensylvanicus Poir. 26601

Rubiaceae
Diodia teres Walt. 25963
Galium aparine L. 29533
Galium circaezans Michx. 29836
Galium pilosum Ait. 25273

Rutaceae
Zanthoxylum americanum Mill. 29966

Salicaceae
Populus alba L. P36118
Populus deltoides Marsh. 29967
Salix humilis Marsh. 25810
Salix nigra Marsh. 30487

Santalaceae
Comandra umbellata (L.) Nutt. 29695

Saxifragaceae
Penthorum sedoides L. (JES)

Scrophulariaceae
Lindernia dubia (L.) Pennell (JES)
Nuttallanthus canadensis (L.) Sutton 29532
Penstemon pallidus Small 29696
Scrophularia lanceolata Pursh 29693
Verbascum thapsus L. 29837
Veronica arvensis L. 29538
Veronica peregrina L. 29677
Veronicastrum virginicum (L.) Farw. 30219

Solanaceae
Physalis heterophylla Nees 25970
Physalis virginiana Mill. 30488
Solanum carolinense L. 29968
Solanum ptychanthum Dunal. 25949

Ulmaceae
Celtis occidentalis L. 29969
Ulmus americana L. 29970
Ulmus pumila L. 29971
Ulmus rubra Muhl. P36127

Urticaceae
Parietaria pensylvanica Muhl. 25272
Urtica gracilis Ait. 30411

Verbenaceae
Verbena hastata L. 30996
Verbena stricta Vent. 29972
Verbena urticifolia L. 30218

Violaceae
Viola pedata L. 29682
Viola pedatifida G. Don (JES)
Viola rafinesquii Greene 29443
Viola sagittata Ait. P36098
Viola sororia Willd. (JES)

Vitaceae
Parthenocissus quinquefolia (L.) Planch. 29973
Vitis aestivalis Michx. 29974
Vitis vulpina L. 29838

Zygophyllaceae
Tribulus terrestris L. 29975

VEGETATION SURVEY OF TOMLIN TIMBER NATURE PRESERVE, MASON COUNTY, ILLINOIS

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ABSTRACT: Tomlin Timber Nature Preserve is a dry to dry-mesic sand forest. When surveyed by the Illinois Natural Areas Inventory in 1976, it was dominated by *Quercus velutina* (black oak), *Sassafras albidum* (sassafras) was second in importance and dominated the woody seedling and sapling layer and was common in the small tree diameter classes. In 2004 sassafras dominated the overstory with an importance value (IV) of 54.9 (possible 200), an average dbh of 24.4 cm, and with most individuals in the 10-40 cm diameter classes. Black oak, in contrast, was second with an IV of 38.5, an average dbh of 62.7, and dominated the larger diameter classes. Dead-standing and dead-downed black oaks were common and averaged 51.7 stems/ha. The change in dominance appears to be due to a combination of natural mortality and oak wilt, which was common in the preserve in the early 1980s. Over 157 vascular plant taxa were found in the preserve.

INTRODUCTION

Wind-blown sand deposits, which account for nearly 5% of the land surface of Illinois, occurs on glacial outwash plains associated with erosional events of Wisconsin glaciation in the northern half of the state (Schwegman 1973, King 1981). The Illinois River sand deposits of Cass and Mason counties in the central part of the state, were formed about 14,500 years ago when glacial moraines were breached, resulting in the Kankakee Torrent (Willman and Frye 1970). These flood waters carried huge amounts of sand and gravel that were deposited when the waters slowed upon entering the broad lowlands of the Illinois River valley. Many high quality natural areas that are now Illinois Nature Preserves occur on these sand deposits. We are studying these preserves to determine the composition and structure of the plant communities.

Early works by Hart and Gleason (1907) and Gleason (1910) were the first extensive studies of the sand area vegetation of the state. A few other studies were completed prior to the early 1990s, those being plant species lists for a few natural areas (Maier 1976, Schwegman 1977). More recently the structure and composition of some upland dry sand forest communities and dry sand savanna communities were examined (Jenkins et al. 1991, Coates et al. 1992, McClain et al. 2002). The purpose of the present study was to examine the composition and structure of Tomlin Timber Nature Preserve, a sand forest remnant on the Illinois River sand deposits in Mason County.

DESCRIPTION OF THE STUDY SITE

Dedicated as a nature preserve in 1987, Tomlin Timber is located about 3 km south of Easton, Mason County, Illinois (NE1/4 SW1/4 S11 T20N R7W). The preserve is on a series of low dunes that lie between 158 and 165 m above sea level in the Illinois River Section of the Mississippi River and Illinois Rivers Sand Areas Natural Division (Schwegman 1973). The soils are excessively drained Bloomfield sand (Calsyn 1995); part of the dune and swale topography known as the Parkland Formation (Willman and Frye 1970).

Little is known about the past history of this 8 ha tract of timber. A comment by Onstot (1902) mentions that Walker's Grove (of which Tomlin Timber is a remnant) "embraces 40 acres of as fine a body of timber as can be found anywhere; a fine growth of oaks, black walnut, soft and sugar maple, hickory, butternut, mulberry, sassafras, redbud, pawpaw, and dogwood". The size of the black oaks, most are in the 50-70 cm diameter classes, suggests that the woods was never clear-cut. When purchased by the Tomlin family in 1912 a one-room schoolhouse was located on the east edge of the property. When surveyed by the Illinois Natural Areas Inventory (White 1978), the owner indicated that the woods had been selectively logged 50 to 60 years ago, but never grazed. Don McFall (Illinois Department of Natural Resources, personal communication) mentions that he first walked through the woods in the early 1980s, and there was a fairly dense woody understory and a number of large dead black oaks.

Based on weather data from Havana about 21 km to the northwest, mean annual precipitation is 96.0 cm, with May having the highest rainfall (11.3 cm). Mean annual temperature is 10.8°C with the hottest month being July (average of 24.6°C), and the coldest January (average of -5.0°C). Frost-free days range from 140 to 206, with the average being 173 days per year (Midwestern Regional Climate Center 2004).

METHODS

During the growing seasons of 2003 and 2004 the study site was visited 12 times. All vascular plant species were collected, their habitat recorded, and voucher specimens deposited in the herbarium of the Illinois Natural History Survey, Champaign, Illinois (ILLS). Criteria for designating non-native species follows Mohlenbrock (2002) and Gleason and Cronquist (1991). Nomenclature follows Mohlenbrock (2002). All species are listed in Appendix I along with the collector and collecting number.

During late summer of 2004 a 150 m by 300 m section of the natural area was surveyed by dividing the area into 72 contiguous quadrates 25 m on a side (4 ha area). The GPS coordinates for the corners of the plot are listed in Appendix II. All living and dead-standing woody individuals $\geq$10.0 cm dbh were identified and diameters recorded. From this data, living-stem density (stems/ha), basal area (m^2/ha), relative density, relative dominance, importance value (IV), and average diameter (cm) were calculated for each species. Determination of the IV follows the procedure used by McIntosh (1957), and is the sum of the relative density and relative dominance (basal area). Dead-standing density (stem/ha) and basal area (m^2/ha) was also determined.

Woody understory composition and density (stems/ha) was determined using nested circular plots 0.0001, 0.001, and 0.01 ha in size located at 15 m intervals along randomly located east-west transects within the study area (72 plots). Four additional 0.0001 ha circular plots were located 7 m from the center points of each of the 72 plot centers along cardinal compass directions (360 plots). In the 0.0001 ha plots, woody seedlings ($\leq$50 cm tall) were counted; in the 0.001 ha circular plots small saplings (>50 cm tall and <2.5 cm dbh) were recorded; and in the 0.01 ha circular plots large saplings (2.5-9.9 cm dbh) were tallied.

RESULTS

At Tomlin Timber Nature Preserve a total of 157 vascular plant species within 125 genera and 61 families were documented. Of these, three were fern and fern-allies, one was a gymnosperms, 122 dicots in 98 genera and 50 families, and 31 monocots in 23 genera and seven families. No threatened or endangered species were found. The predominant plant families were the Poaceae and Asteraceae with 17 taxa each. Thirty one exotic plant taxa were found, about 19% of the flora of the preserve (Appendix I).

Nineteen tree species were present in the overstory (Table 1). *Sassafras albidum* (sassafras) dominated the smaller diameter classes with most individuals being less than 40 cm dbh. This species had an IV of 54.9, averaged 132.5 stems/ha, and averaged 24.4 cm dbh. *Quercus velutina* (black oak), restricted to the larger diameter classes, was second in IV (38.5), averaged 25.4 stems/ha, and averaged 62.7 cm dbh. The remaining trees were mostly in the 10-39 cm diameter classes, *Carya texana* (black hickory) averaged 90.1 stems/ha, *Celtis occidentalis* (hackberry) averaged 80.7 stems/ha, and *Prunus serotina* (black cherry) averaged 52.8 stems/ha, all with IVs below 31 and average diameters less than 20 cm dbh.

The woody understory was dense with 18,639 woody seedlings/ha, 4,862 small saplings/ha, and 1,222 large saplings/ha (Table 2). Few open areas existed in the woody understory, the more open areas being under the extensive colonies of *Asimina triloba* (pawpaw) (Table 2). Pawpaw averaged 4,028 seedlings/ha, 2,986 small saplings/ha, 854 large saplings/ha, along with 14.9 stems/ha that exceeded 10 cm dbh (Table 1 and 2). Few other taxa occurred under these dense pawpaw colonies. Hackberry, sassafras, *Carya cordiformis* (bitternut hickory), and *Ulmus americana* (American elm) were also extremely common. Many other tree species were present, but in relatively low numbers. Woody shrubs and vines were also important in the understory, *Toxicodendron radicans* (poison ivy), *Rubus pennsylvanicus* (blackberry), and *Ribes missouriense* (Missouri gooseberry) being the most common (Table 2).

Dead-standing individuals averaged 43.5 stems/ha with a basal area of 5.059 m^2/ha, the most important being black oak, sassafras and American elm (Table 3). Sassafras exceeded black oak in the number of dead-standing stems/ha, but dead-standing black oak was responsible for most of the basal area (4.188 of 5.059 m^2/ha). Dead-downed trees were common and averaged 46.7 stems/ha with a basal area of 6.115 m^2/ha. Black oak was the most important taxon in this category accounting for 37.3 stems/ha and 5.781 m^2/ha of basal area (Table 3).

DISCUSSION

Using Government Land Office survey records, Rodgers and Anderson (1979) described the presettlement vegetation of Mason County. They found that black oak was the dominant woody species in open forest communities, where it usually accounted for half of the IV. Species diversity was high in these open forests with *Carya* spp. (hickories), *Acer* spp. (maples), *Quercus alba* (white oak), *Ulmus* spp. (elms), and *Fraxinus* spp. (ash) following black oak in IV. The many small diameter witness trees reported in the GLO survey indicates that oaks and hickories were reproducing, and these relatively shade-intolerant species were replacing themselves (Rodgers and Anderson 1979).

Tomlin Timber is probably very different today compared to the early 1800s due to a reduced fire frequency followed by a total absence of fire in recent decades (Taft 1997). Frequent fires in presettlement times were probably responsible for maintaining a relatively open forest with a reduced understory (Ebinger and McClain 1991, McClain and Elzinga 1994). Their thick bark and ability to reproduce by sprouts gave oaks a competitive advantage in areas of high fire frequencies. Fire frequency and intensity dictated oak density in this presettlement landscape (Anderson 1991, Abrams 1992). The compositional stability of these open forest communities indicates that the open habitat necessary for the reproduction of these species was being maintained, probably by fire.

When surveyed by the Illinois Natural Areas Inventory in 1976, the preserve was considered an old-growth "grade A" dry upland sand forest due to the "excellent timber of good size, height, and form" (Wallace and Rowe 1976). Tree density averaged 244 stems/ha with a basal area of 27.6 m^2/ha. Black oak was the dominant overstory species with 120 stems/ha and a basal area of 22.0 m^2/ha, most of the individuals in the 50 to 70 cm diameter classes. Sassafras, *Carya tomentosa* (mockernut hickory), and black hickory followed in importance. The sapling layer averaged 3,900 stems/ha, sassafras being the dominant species with 1,700 stems/ha (Wallace and Rowe 1976).

Most of the forests previously studied in the Illinois River sand deposits were closed canopy dry sand forests located on dune deposits where black oak and *Quercus marilandica* (blackjack oak) were usually the leading dominants along with a few hickory species. Black hickory occasionally replaced blackjack oak as second in IV in those forests, while sassafras and elms were not present. All probably represented sand savannas that have since become closed forests due to fire suppression (Jenkins et al. 1991, Coates et al. 1992, McClain et al. 2002).

Tomlin Timber was probably an open, dry-mesic sand forest (woodland) community in presettlement times. Canopy closure and the increase in importance of mesic trees, resulting from fire suppression, has altered the structure of Tomlin Timber. With canopy closure shade-intolerant black oaks could not effectively reproduce. Sassafras, a fire-sensitive, but relatively shade-tolerant species, became the dominant understory species, eventually entered the canopy and now is the dominant species.

The high mortality of black oak observed in the woods indicates that this species was susceptible to oak wilt (Henry et al. 1944). Oak wilt disease was observed in the woods in the early 1980s, and several large diameter black oaks were killed (W.E. McClain, personnal observation). The death of large oaks created canopy openings that were filled by sassafras. Though the growth of sassafras is not rapid, this species has a relatively high gap-phase-replacement potential and commonly reproduces by root suckers.

At the present time no black oaks were observed in the sapling or 10-20 cm diameter class, suggesting that this species will continue to decrease in importance at the veteran trees die. Also, few individuals of black oak were in the 20-29 cm diameter class. Tomlin timer is another example of oaks being replaced by more mesic tree species due

to a very reduced fire frequency (Ebinger and McClain 1991, Taft 1977). The loss of dominance by black oak since the 1976 inventory has been profound. This site no longer qualifies as an "old growth grade A" forest community.

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Table 1. Densities (stems/ha), diameter classes (cm), basal areas (m^2/ha), relative values, importance values and average diameters of the woody species at Tomlin Timber Nature Preserve, Mason County, Illinois.

Species	Diameter Classes (cm) 10-19	20-29	30-39	40-49	50-59	60-69	70+	Total #/ha	Basal Area m^2/ha	Rel. Den.	Rel. Dom.	I.V.	Av. Diam. (cm)
Sassafras albidum	41.1	59.8	26.7	4.2	0.7	--	--	132.5	6.898	26.5	28.4	54.9	24.4
Quercus velutina	--	0.7	0.9	1.1	5.8	11.6	5.3	25.4	8.102	5.1	33.4	38.5	62.7
Carya texana	51.6	34.0	3.8	0.7	--	--	--	90.1	2.905	18.1	12.0	30.1	19.3
Celtis occidentalis	64.7	13.1	2.0	0.7	--	0.2	--	80.7	1.900	16.2	7.8	24.0	16.2
Prunus serotina	42.0	8.0	2.2	0.4	--	--	0.2	52.8	1.380	10.6	5.7	16.3	16.7
Ulmus americana	31.8	5.8	--	--	--	--	--	37.6	0.791	7.5	3.3	10.8	15.7
Carya tomentosa	13.3	10.0	3.6	0.2	--	--	--	27.1	1.051	5.4	4.3	9.7	20.9
Ulmus rubra	24.4	4.4	0.4	--	--	--	--	29.2	0.626	5.9	2.6	8.5	15.7
Asimina triloba	14.9	--	--	--	--	--	--	14.9	0.166	3.0	0.7	3.7	11.8
Others[1] (10 species)	4.2	1.3	1.1	0.9	0.2	0.2	--	7.9	0.466	1.7	1.8	3.5	
Total	288.0	137.1	40.7	8.2	6.7	12.0	5.5	498.2	24.285	100.0	100.0	200.0	

1. Includes *Juglans nigra* (black walnut), *Carya cordiformis* (bitternut hickory), *Morus rubra* (red mulberry), *Morus alba* (white mulberry), *Acer saccharum* (sugar maple), *Robinia pseudoacacia* (black locust), *Catalpa binonioides* (catalpa), *Acer saccharinum* (silver maple), *Maclura pomifera* (Osage orange), and *Diospyros virginiana* (persimmon).

Table 2. Density (stems/ha) of woody understory species at Tomlin Timber Nature Preserve, Mason County, Illinois.

Species	Seedlings	Small Saplings	Large Saplings
Asimina triloba	4028	2986	854
Celtis occidentalis	2000	944	115
Sassafras albidum	1806	625	103
Cary cordiformis	1667	167	25
Ulmus americana	1222	56	18
Ulmus rubra	361	42	21
Quercus velutina	333	--	--
Carya texana	250	--	8
Maclura pomifera	139	--	11
Morus alba	111	28	--
Prunus serotina	83	14	61
Gleditsia triacanthos	28	--	--
Jugland nigra	--	--	4
Acer negundo	--	--	1
Morus rubra	--	--	1
Toxicodendron radicans	2194	--	--
Rubus pensilvanica	1944	--	--
Ribes missouriense	1306	--	--
Sambus canadensis	389	--	--
Rubus occidentalis	278	--	--
Zanthoxylum americanum	250	--	--
Rubus flagellaris	139	--	--
Rosa multiflora	83	--	--
Lonicera maackii	28	--	--
Totals	18639	4862	1222

Table 3. Density (stems/ha), basal area (m^2/ha), and average diameter of the dead-standing and dead-downed tree species at Tomlin Timber Nature Preserve, Mason County, Illinois.

	DEAD-STANDING			DEAD-DOWNED		
Tree Species	Density (stems/ha)	Basal Area (m^2/ha)	Average Diameter (cm)	Density (stems/ha)	Basal Area (m^2/ha)	Average Diameter (cm)
Quercus velutina	14.4	4.188	59.2	37.3	5.781	43.1
Sassafras albidum	17.1	0.532	19.2	3.6	0.158	23.0
Ulmus rubra	4.2	0.083	15.5	2.9	0.079	18.3
Ulmus americana	2.7	0.085	19.3	1.8	0.059	20.0
Prunus serotina	2.0	0.057	17.7	0.2	0.010	23.8
Carya tomentosa	0.9	0.055	26.0	--	--	--
Carya texana	0.9	0.033	21.1	0.9	0.028	19.0
Asimina triloba	0.9	0.011	12.6	--	--	--
Acer saccharinum	0.4	0.015	20.8	--	--	--
Totals	43.5	5.059		46.7	6.115	

APPENDIX I. Vascular species encountered at Tomlin Timber Nature Preserve, Mason County, Illinois, listed alphabetically by family under the major plant groups. An asterisk indicates non-native (exotic) species (*). Following the scientific name, collecting numbers preceded by the initial of the collector's name are given (E) James Ellis and (P) Loy R. Phillippe.

PTERIDOPHYTES

DRYOPTERIDACEAE

Dryopteris cartusiana (Villars) H.P. Fuchs: P 36729

ONOCLEACEAE

Onoclea sensibilis L.: P 36064

OPHIOGLOSSACEAE

Botrychium virginianum (L.) Sw.: P 36680

SPERMATOPHYTES: GYMNOSPERMS

CUPRESSACEAE

Juniperus virginiana L.: P 36049

SPERMATOPHYTES: ANGIOSPERMS

MONOCOTS

ARACEAE

Arisaema triphyllum (L.) Schott: P 36685

COMMELINACEAE

**Commelina communis* L.: P 35988
Tradescantia ohiensis Raf.: P 35987

CYPERACEAE

Carex blanda Dewey: P 36678
Carex festucacea Schk.: P 36707, P 36728, P 36732
Carex grisea Wahl: P 36679, P 36690
Cyperus lupulinus (Spreng.) Marcks var. *macilentus* (Fern.) Marcks: P 35982

JUNCACEAE

Juncus tenuis Willd.: P 36041

LILIACEAE

Lilium michiganense Farw.: P 36061
**Ornithogalum umbellatum* L.: P 36676
Smilacina racemosa (L.) Desf.: P 36014
Smilacina stellata (L.) Desf.: E 53, P 36013

POACEAE

**Bromus inermis* Leyss.: P 36068
**Bromus tectorum* L.: P 36688
**Dactylis glomerata* L.: P 36725
**Digitaria sanguinalis* (L.) Scop.: P 36040
Elymus villosus Muhl.: P 36043
Elymus virginicus L.: P 36025
Eragrostis spectabilis (Pursh) Steud.: P 35985

Festuca subvertiacillata (Pers.) E.B. Alexeev: P 36057
Hordeum pusillum Nutt.: P 36727
Leersia virginica Willd.: P 36061
Muhlenbergia frondosa (Poir.) Fern.: E 55
Muhlenbergia schreberi J.F. Gmel.: P 36032
Paspalum bushii Nash: P 35976
Poa pratensis L.: P 36699, P 36701
**Poa sylvestris* Gray: P 36677
**Setaria faberi* R.A.W. Herrm.: P 35998
Tridens flavus (L.) Hitchc.: P 35981

SMILICACEAE

Smilax tamnoides L. var. *hispida* (Muhl.) Fern.: P 36004
Smilax lasioneuron Hook.: P 36054

DICOTS

ACANTHACEAE

Ruellia humilis Nutt.: P 35978

ACERACEAE

Acer negundo L.: P 37298
Acer saccharinum L.: P 37360
Acer saccharum Marsh.: P 37356

ANACARDIACEAE

Toxicodendron radicans (L.) Kuntze: P 36003

ANNONACEAE

Asimina triloba (L.) Dunal: P 36016

APIACEAE

Chaerophyllum procumbens (L.) Crantz: P 36674
Osmorhiza longistylis (Torr.) DC.: P 36672.2
Sanicula canadensis L.: P 36011
Sanicula odorata (Raf.) Pryer & Phillippe: P 36021

ASTERACEAE
Ageratina altissima (L.) R.M. King & H. Rob.: P 36010
Ambrosia artemisiifolia L.: P 36036
Ambrosia trifida L.: P 36047
Arnoglossum atriplicifolia (L.) H. Rob.: P 35972
Aster ontarionis Wieg.: E 58, E 59
Aster pilosus Willd.: E 48
Bidens bipinnata L.: P 35979
Conyza canadensis (L.) Cronq.: P 36035
Eupatoroiadelphus purpureus (L.) R.M. King & H. Rob.: P 36052
Eupatorium serotinum Michx.: P 36039
Helianthus divaricatus L.: P 36006
Heterotheca subaxillaris (Lam.) Britt. & Rusby: P 35986
Lactuca canadensis L.: P 36050
Lactuca floridana (L.) Gaertn.: P 36020
Rudbeckia hirta L.: P 35993
Solidago canadensis L.: P 35991
Solidago gigantea Ait.: E 51

BERBERIDACEAE

Podophyllum peltatum L.: P 36683

BIGNONIACEAE

**Catalpa bignonioides* Walt.: P 37357

BORAGINACEAE

**Buglossoides arvense* (L.) I.M. Johnston: P 36696
Hackelia virginiana (L.) I.M. Johnston: P 35994

BRASSICACEAE

**Alliaria petiolata* (Bieb.) Cavara & Grande: P 36673
Arabis glabra (L.) Bernh.: P 36730
**Capsella bursa-pastoris* (L.) Medik.: P 36693

CAESALPINIACEAE

Gleditsia triacanthos L.: P 36056

CANNABINACEAE

**Cannabis sativa* L.: P 36029
Humulus lupulus L.: P 36019

CAPRIFOLIACEAE

**Lonicera maackii* (Rupr.) Maxim.: P 36682
Sambucus canadensis L.: P 36051

CARYOPHYLLACEAE

**Arenaria serpyllifolia* L.: P 36691
**Cerastium pumilum* Curtis: P 36697
**Holosteum umbellatum* L.: P 36702
**Saponaria officinalis* L.: P 35983
Silene stellata (L.) Ait. f.: P 36009

CELASTRACEAE

Celastrus scandens L.: P 36048

CHENOPODIACEAE

**Chenopodium album* L.: E 49

CORNACEAE

Cornus drummondii C.A. Mey.: P 36007

CORYLACEAE

Corylus americana Walt.: P 36065

EBENACEAE

Diospyros virginiana L.: P 37361

ELAEAGNACEAE

*Elaeagnus umbellata Thunb.: E 57, P 36723

EUPHORBIACEAE

Acalypha gracilens Gray: P 35974
Acalypha virginica L.: P 35975
Chamaesyce nutans (Lag.) Small: P 36053
Croton glandulosus L.: P 35973
Phyllanthus caroliniensis Walt.: P 36059
Poinsettia dentata Michx.: E 52P 35977

FABACEAE

**Medicago lupulina* L.: P 36726
**Melilotus albus* Medic.: P 35992
**Robinia pseudoacacia* L.: P 37297

FAGACEAE

Quercus velutina Lam.: P 36070

GROSSULARIACEAE

Ribes missouriense Nutt.: P 36012

HYDROPHYLLACEAE

Ellisia nyctelea L.: P 36681

JUGLANDACEAE

Carya cordiformis (Wangenh.) K. Koch: P 36026
Carya illinoiensis (Wangenh.) K. Koch: P 36063
Carya texana Buckl.: P 36001
Carya tomentosa (Poir.) Nutt.: P 36018
Juglans nigra L.: P 36071

LAMIACEAE

Agastache nepetoides (L.) Ktze.: P 36008
**Leonurus cardiaca* L.: P 36722
**Nepeta cataria* L.: P 36005
Teucrium canadense L.: P 36055

LAURACEAE

Sassafras albidum (Nutt.) Nees.: P 36000

MALVACEAE

Callirhoë triangulata (Leavenw.) Gray: P 35970

MOLLUGINACEAE

**Mollugo verticillata* L.: P 36038

MORACEAE

**Maclura pomifera* (Raf.) Schneider: P 36066
**Morus alba* L.: P 36045
Morus rubra L.: P 36045

NYCTAGINACEAE

**Mirabilis nyctaginea* (Michx.) MacM.: P 35996

ONAGRACEAE

Circaea lutetiana L.: P 36024
Oenothera biennis L.: P 36042
Oenothera laciniata Hill: P 36704

OXALIDACEAE

Oxalis stricta L.: P 35989

PHRYMACEAE

Phryma leptostachya L.: E 56, P 36023

PHYTOLACCACEAE

Phytolacca americana L.: P 35984

PLANTAGINACEAE

Plantago rugelii Decne.: P 35997
Plantago virginica L.: P 36731

POLYGALACEAE

Polygala verticillata L.: P 35971

POLYGONACEAE

Antenoron virginianum (L.) Roberty & Vautier: P 36030
Fallopia scandens (L.) Holub.: E 50
Persicaria punctata (Ell.) Small: P 36028

PORTULACCACEAE

Claytonia virginica L.: P 36686

RANUNCULACEAE

Anemone virginiana L.: P 36037
Ranunculus abortivus L.: P 36687

ROSACEAE

Fragaria virginiana Duchesne: P 36689
Geum canadense Jacq.: P 35995
Prunus serotina Ehrh.: P 36067
Rosa carolina L.: P 36724
**Rosa multiflora* Thunb.: E 54
Rubus flagellaris Willd.: P 36698
Rubus occidentalis L.: P 36706
Rubus pensilvanicus Poir.: P 36705

RUBIACEAE

Galium aparine L.: P 36675

RUTACEAE

Zanthoxylum americanum Mill.: P 37359

SCROPHULARIACEAE

Penstemon pallidus Small: P 36703
Scrophularia lanceolata Pursh: P 36027

**Verbascum thapsus* L.: P 36033
Veronica arvensis L.: P 36694

SOLANACEAE

Physalis heterophylla Nees: P 35980
Physalis subglabrata Mack. & Bush: P 35999
Solanum caroliniense L.: P 35990
Solanum ptychanthum Dunal: P 36058

ULMACEAE

Celtis occidentalis L.: P 36002
Ulmus americana L.: P 37358
Ulmus rubra Muhl.: P 36044

URTICACEAE

Laportea canadensis (L.) Wedd.: P 36022

VERBENACEAE

Verbena stricta Vent.: P 36015
Verbena urticifolia L.: P 36069

VIOLACEAE

Viola pratincola Greene: P 36684
**Viola rafinesquei* Greene: P 36072
Viola sororia Willd.: P 36695

VITACEAE

Vitis aestivalis Michx.: P 36034
Vitis riparia Michx.: P 36060

Changes in a sand savanna due to disturbance and fire suppression, Sand Ridge State Forest, Mason County, Illinois.

Loy R. Phillippe, Paul B. Marcum, Daniel T. Busemeyer, William E. McClain, and John E. Ebinger, Illinois Natural History Survey, Champaign, Illinois 61820

ABSTRACT - Sand savannas, dominated by *Quercus velutina* Lam. (black oak) are still relatively common in the major sand deposits of Illinois. Most, however, are extensively degraded by fire suppression and invasion by woody and exotic species. Many are now closed forests that lack characteristic ground layer species. Degraded savannas, that are presently dry sand forests, are the dominant community of ridges and slopes on large stabilized dunes at Sand Ridge State Forest, Mason County, Illinois. In the community examined black oak, with an importance value of 143.5, averaged 321.1 stems/ha, and accounted for 78% of the total basal area. *Quercus marilandica* Muench. (blackjack oak) was second followed by *Pinus strobus* L. (white pine) and *Carya texana* Buckl. (black hickory). Based on early aerial photographs this closed forest had an open overstory in the early 1940s.

INTRODUCTION

Savanna communities are generally defined as having overstories consisting of scattered, open-grown trees and a herbaceous grass dominated ground layer (Curtis 1959, Bray 1960, Nuzzo 1986, White and Madany 1978). In the prairie forest interface of the prairie peninsula of Illinois the presence of prairie, savanna, woodland, and forest communities was determined largely by environmental factors, including the extent and intensity of fire, climate, and topography (Transeau 1935, Anderson 1991, Ebinger and McClain 1991, Abrams 1992). Other contributing factors important on a local level included coarseness of the soil, frequency of local droughts, and browsing by large herbivores (Nuzzo 1986).

Savanna communities were extremely common in the landscape of Illinois in the 1800s. Journals of many early travelers and settlers recount the open park-like landscape in many parts of the state (Bourne 1820, Engelmann 1863, Vestal 1936). Government Land Office (GLO) survey records also indicate that many "forests" were actually savanna and woodland communities based on the distance of witness trees to corner posts (Cottam and Curtis 1949, Clements 1958, Hutchison 1988). Furthermore, many present day old growth forests still retain a few open-grown "wolf trees" with low branches and branch-scars, indicating that they were formerly part of an open landscape (Curtis 1959, Ebinger and McClain 1991).

European man destroyed most "black soil" savannas of Illinois soon after settelment. The few trees and thinner, often drier sod, made savannas easier to plow with the early wooden plows than "black soil" prairies. The few savanna communities that remain are extensively degraded by a massive influx of exotic species and canopy closure due to fire suppression and subsequent woody invasion.

Savanna communities are still relatively common in the northern half of Illinois on major sand deposits. These deposits are mostly on outwash plains that resulted from erosional events associated with Wisconsin glaciation (Willman and Frye 1970, King 1981). Gleason (1910), and more recently Jenkins et al. (1991), Coates et al. (1992), McClain et al. (2002) studied the structure and composition of woodland communities of the Illinois River sand deposits. Also, Rodgers and Anderson (1979) studied the presettlement vegetation of Mason

County. Mostly modified by human activity, a few nature preserves and other good quality natural areas remain. The present study was undertaken to determine the woody overstory and understory species composition and structure of a degraded savanna that still retains some of its original structure at Sand Ridge State Forest.

DESCRIPTION OF THE STUDY SITE

Sand Ridge State Forest is located in northwestern Mason County about 21 km northwest of Havana, and just west of Forest City, Illinois (parts of townships T22N R7W and T23N R7W). This 3,035 ha (11.7 sq. miles) state forest, with initial land purchases starting in 1939, lies within the Illinois River Section of the Mississippi River and Illinois River Sand Area Natural Division in Mason and Cass counties (Schwegman 1973, Willman 1973). These deposits were formed about 14,500 years ago when glacial moraines and ice dams were breached. The resulting flood, the Kankakee Torrent, carried extensive deposits of sand and gravel from glacial lakes in northeastern Illinois and adjacent Indiana. Most of this sand and gravel was deposited when the waters of the Kankakee Torrent slowed upon entering the broad lowlands of the Illinois River. These deposits were then reworked by winds creating the present dune and swale topography.

The original reason for purchasing the land for what is now the Sand Ridge States Forest was to stabilize soil on abandoned farmlands, develop a wood product industry, and set land aside for recreation (Andrews 2004). During the early years, and into the 1950's, pine plantations were established within this state forest, mostly on old pastureland and abandoned cultivated fields, but also in dry sand prairies. Some pines were also planted in savannas. Presently 1,012 ha of marketable pine plantations are found in the state forest with most of the remainder in oak-hickory dry sand forest and savanna (Andrews 2004).

Sand Ridge State Forest has a continental climate with warm summers and cold winters. Based on weather data from Havana, mean annual precipitation is 96.0 cm, with May having the highest rainfall (11.3 cm). Mean annual temperature is 10.8°C with the hottest month being July (average of 24.6°C), and the coldest January (average of -5.0°C). Frost-free days range from 140 to 206, with the average being 173 days per year (Midwestern Regional Climate Center 2004). The soils are mostly excessively drained Plainfield and Bloomfield sands (Calsyn 1995) that form the dune and swale topography known as the Parkland Formation (Willman and Frye 1970).

METHODS

During late summer of 2004 a 100 m by 300 m section of the state forest was surveyed by dividing the area into 48 contiguous quadrates 25 m on a side. This 3 ha area was located on a large stabilized dune having an east/west orientation, the centerline of the transect running along the ridge of the dune (N1/2 NW1/4 NE1/4 S4 T22N R7W). The GPS readings for the transect line are reported in Appendix II. All living and dead-standing woody individuals $\geq$10.0 cm dbh were identified and their diameters recorded. From this data, living-stem density (stems/ha), basal area (m^2/ha), relative density, relative dominance, importance value (IV), and average diameter (cm) were calculated for each species. Determination of the IV follows the procedure used by McIntosh (1957), and is the sum of the relative density and relative dominance (basal area). Dead-standing density (stem/ha) and basal area (m^2/ha) was also determined. Nomenclature follows Mohlenbrock (2002).

Woody understory composition and density (stems/ha) were determined using nested circular plots 0.0001, 0.001, and 0.01 ha in size located at about 15 meter intervals along randomly located east-west line transects within the study area

(48 plots). Four additional 0.0001 ha circular plots were located 7 m from the center points of each of the 48 plot centers along cardinal compass directions (240 plots). In the 0.0001 ha plots, woody seedlings (≤50 cm tall) and shrubs and vines were counted; in the 0.001 ha circular plots small saplings (>50 cm tall and <2.5 cm dbh) were recorded; and in the 0.01 ha circular plots large saplings (2.5-9.9 cm dbh) were tallied.

To determine the change in total overstory cover within the state forest aerial photographs from 1939, 1967, and 1988 were digitized to determine the extent of woody encroachment (trees and large shrubs). The 1939 aerial photographs were taken in July, the 1967 in May, and the 1988 in April. These photographs were borrowed from the University of Illinois Map Library and scanned with a Microtek ScanMaker. A total of 20 stratified randomly located 5 ha circular plots (100 ha total area), representing approximately 20% of the study sites, were interpreted and then digitized using ARC/INFO.

RESULTS

Eleven tree species were encountered in the overstory (Table 1). Black oak dominated all diameter classes with the 10-29 cm diameter classes accounting for more than 75% of all individuals and only 3 stems/ha greater than 60 cm dbh. This species had an IV of 143.5, averaged 321.1 stems/ha, averaged 23.6 cm dbh, and accounted for 78.1% of the total basal area. *Quercus marilandica* Muench. (blackjack oak), second in IV, was mostly restricted to smaller diameter classes, averaged 111.6 stems/ha, and averaged 16.5 cm dbh. The remaining species were mostly in the 10-39 cm diameter classes, *Carya texana* Buckl. (black hickory) averaged 26.3 stems/ha, while *Pinus strobus* L. (white pine) averaged 26.1 stems/ha. Coppice stems accounted for about 16% of the stems encountered. Black oak accounted for the majority, averaging 27 coppice trees/ha with 57.7 stems/ha (Table 2).

Dead-standing individuals averaged 24.6 stems/ha with a basal area of 1.01 m^2/ha, nearly all being oaks. Black oak averaged 15.6 dead-standing stems/ha while blackjack oak accounted for nearly all of the remainder. Most of the dead-standing individuals were in the lower diameter classes and most had basal fire-scars. A few dead-standing black oaks exceeded 40 cm dbh.

The woody understory averaged 15,200 seedlings/ha, 1,775 small saplings/ha, and 295 large saplings/ha (Table 3). Seedling density was relatively high but the majority was shrubby species. Black oak and black hickory accounted for nearly all of the tree seedlings. Because of the relatively few saplings, the woody understory was open. Again, black oak and black hickory accounted for the majority of the individuals (Table 3). Woody shrubs were also important in the understory, *Rubus allegheniensis* Porter (common blackberry), *Rhus aromatica* Ait. (fragrant sumac), *Toxicodendron radicans* (L.) Kuntze (poison ivy), and *Cornus drummondii* C. A. Mey. (rough-leaved dogwood) being the most common (Table 3).

Based on aerial photographs from 1939, 1967, and 1988, the density of the woody overstory has increased dramatically. Of the 100 ha (20 plots each 5 ha in size) analyzed in 1939 all sites were very open (00.000 ha of woody overstory), by 1967 woody cover had nearly doubled (00.000 ha), while by 1988 woody cover again increased significantly (00.000 ha). This represents an increase of 00.000 ha of woody overstory in about 50 years (Table 4).

DISCUSSION

The forests of Sand Ridge State Forest are very different today compared to the early 1800s, mostly due to a reduced fire frequency followed by the total absence of fire in recent decades (Taft 1997). There has been a dramatic

increase in canopy cover in the past 65 years: from _____ in 1939 to _____ in 1988 (Table 4). In presettlement times repeated fires were probably responsible for maintaining an open forest with a sparse understory (Ebinger and McClain 1991, McClain and Elzinga 1994). In those forests the larger trees maintained an open-grown appearance with low branches and branch-scars. A few large, open-grown trees remained in the study plots. Because of fire and droughty conditions, most of this forest was originally woodland and savanna communities with numerous small, scattered prairie openings. Canopy closure resulted from fire suppression and the subsequent woody invasion by native species.

Presently occasional fires and the droughty conditions have allowed for the perpetuation of oak species. Black oak is reproducing on the site with numerous seedlings and saplings in the understory (Table 3). Blackjack oak, in contrast, has a very low rate of reproduction. The large number of seedlings, saplings, and small diameter trees of black hickory suggests that this species will increase in importance. As canopy closure continues, the shade-intolerant oaks may not effectively reproduce. Black hickory, a fire-sensitive, but relatively shade-tolerant species, could become the dominant understory species and became more common in the lower diameter classes.

Woody exotic species are common in Sand Ridge State Forest. At least 10 species of pine were planted in the 1940s and early 1950s, and many pine plantations are present (Maier 1976, Andrews 2004). The most commonly planted species was white pine. Rows of individuals of this introduced exotic species were present in our study plots, indicating this species was also planted in the native hardwood forests and savannas. Smaller individuals, plus occasional seedlings indicate that this species is reproducing.

Using GLO survey records, Rodgers and Anderson (1979) described the presettlement vegetation of Mason County. They found that tree density averaged 7.44 trees/ha with an average basal area of 1.19 m^2/ha in savanna communities. Black oak was, by far, the dominant woody species, accounting for more than half of the IV. Blackjack oak was second in IV followed by various species of hickory. The many small diameter witness trees reported in the GLO survey indicate that oaks and hickories were reproducing, and these relatively shade-tolerant species were replacing themselves in savanna, woodland, and closed forest communities (Rodgers and Anderson 1979).

Most forests studied within the Illinois River sand deposits were closed canopy dry sand forests located on dune deposits where black and blackjack oaks were usually the leading dominants along with a few hickory species. Black hickory occasionally replaced blackjack oak as second in IV in those forests (Jenkins et al. 1991, Coates et al. 1992, McClain et al. 2002). All probably represented sand savannas that have become closed forests due to fire suppression and woody species invasion. An increased fire frequency and some timber harvesting will be necessary to restore the woodland and savanna communities that once existed at Sand Ridge State Forest.

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Table 1. Densities (stems/ha), diameter classes, basal areas (m^2/ha), relative values, importance values and average diameters of the woody species at Sand Ridge State Forest, Mason County, Illinois.

Species	Diameter Classes (cm) 10-19	20-29	30-39	40-49	50-59	60+	Total #/ha	Basal Area m^2/ha	Rel. Den.	Rel. Dom.	I.V.	Av. Diam. (cm)
Quercus velutina	145.3	107.7	37.7	20.7	6.7	3.0	321.1	16.995	65.4	78.1	143.5	23.6
Quercus marilandica	92.0	17.0	2.3	0.3	--	--	111.6	2.601	22.8	11.9	34.7	16.5
Pinus strobus	12.7	8.7	2.7	2.0	--	--	26.1	1.243	5.3	5.7	11.0	23.0
Carya texana	20.0	3.3	1.7	1.0	0.3	--	26.3	0.849	5.4	3.9	9.3	17.9
Others (7 species*)	5.7	--	--	--	--	--	5.7	0.080	1.1	0.4	1.5	
Total	275.7	136.7	44.4	24.0	7.0	3.0	490.8	21.768	100.0	100.0	200.0	

*Other species include: *Carya tomentosa* (Poir.) Nutt., *Diospyros virginiana* L., *Juniperus virginiana* L., *Pinus banksiana* Lamb., *Pinus sylvestris* L., *Prunus serotina* Ehrh., *Ulmus americana* L.

Table 2. Density (#/ha) of coppice trees and stems, coppice stems per tree, average basal area (m^2/ha) of coppice stems, and the average diameter (cm) of coppice stems at Sand Ridge State Forest, Mason County, Illinois.

Species	Trees (#/ha)	Stems (#/ha)	Stems/trees	Basal Area (m^2/ha)	Average Diameter (cm)
Quercus velutina	27.0	57.7	2.1	2.721	23.4
Quercus marilandica	9.0	19.3	2.2	0.540	17.9
Carya texana	1.7	3.3	2.0	0.099	17.1
Totals	37.7	80.3		3.360	

Table 3. Density (individuals/ha) of woody understory species in a woodland community at Sand Ridge State Forest, Mason County, Illinois.

Species	Seedlings	Small Saplings	Large Saplings
Quercus velutina	3750	575	100.0
Carya texana	2850	600	85.0
Prunus serotina	250	250	20.0
Quercus marilandica	250	25	30.0
Carya tomentosa	150	125	17.5
Pinus strobus	150	25	17.5
Juniperus virginiana	--	100	15.0
Pinus sylvestris	--	--	5.0
Ulmus americana	--	--	2.5
Celtis occidentalis	--	--	2.5
Rubus allegheniensis	2250	--	--
Rhus aromatica	1850	--	--
Toxicodendron radicans	1650	--	--
Cornus drummondii	1600	50	--
Rubus occidentalis	300	--	--
Ribes missouriense	100	--	--
Viburnum prunifolium	50	--	--
Lonicera maackii	--	25	--
Totals	15200	1775	295.0